Appendix 11.3

FLOOD RISK ASSESSMENT

BUROHAPPOLD ENGINEERING

The People's Project

Flood Risk Assessment

040026

20 August 2020

Revision 07

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Glossary

Term	Definition
Annual Exceedance Probability (AEP)	The Probability that a storm event will be exceeded in any given year
Attenuation	A method to reduce a flood peak to prevent flooding, often utilising temporary storage, but increasing the duration of the flow
Design Flood Event	A historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed. This is typically the 1% AEP (1 in 100) flood level with appropriate allowance for climate change.
Design Flood Level	The maximum estimate water level during the design flood event
Discharge	The rate of flow of water measured in terms of volume per unit time
Flood Defence	A natural or man-made infrastructure used to prevent certain areas from inundation from flooding, and / or the provision of flood warning systems
Floodplain	Area of land adjacent to a water course which water flows or is stored during a flood event, or would otherwise be flooded in the absence of flood defences
Flood Resilience	Improving flood resistance, e.g. reducing the risk of properties against flooding events
Flood Risk	The level of risk to personal safety and damage to property resulting from flooding due to the frequency or likelihood of flood events
Flood Risk Assessment	An assessment of the flood risks to the proposed development over its expected lifetime and the possible flood risks to the surrounding areas, assessing flood flows, flood storage capacity and runoff
Flood Warning Systems	A system by which to warm the public of the potential of imminent flooding. This is typically linked to a flood forecasting system
Fluvial Flooding	Related or connected to a watercourse (river or stream)
Freeboard	Allowance made between the finished flood levels of a building or top of flood defence and the Design Flood Level, to accommodate modelling or other uncertainties
Groundwater Flooding	Water occurring below ground in natural formations (typically rocks, gravels and sands)
Impermeable Surface	A surface that does not permit the infiltration of water and, therefore, generates surface water runoff during periods of rainfall
Inundation	Flooding of land with water
Mitigation	Actions taken to reduce either the probability of flooding or the consequences of flooding or a combination of the two
Red line boundary	Boundary drawn to indicate the site area on which the planning application is based
Residual Risk	The risk that remains after risk management and mitigation measures have been implemented
Return Period	The average frequency of a specified condition. An 'n' year event is one that occurs on average over the long term, once every 'n' years
Risk	Risk is the probability that an event will occur and the impact (or consequences) associated with that event
Runoff	Water flow over surfaces to the drainage system. Runoff occurs if the ground is impermeable or if permeable ground is saturated.
Strategic Flood Risk Assessment	An SFRA is the assessment and 'categorisation' of flood risk on an area-wide basis in accordance with PPS25 (now superseded by the NPPF)
Surface Water Flooding	Surface water flooding occurs when the volume of water is unable to filtrate through the ground to enter drainage systems, and therefore runs quickly off land and results in localised flooding. This type of flooding is usually associated with intense rainfall.
Sustainable Drainage Systems (SuDS)	SuDS are used as a strategy to manage surface water in a sustainable manner or least damaging solution through management practices and physical structures.

Abbreviations

Term	Definition
Bgl	Below ground level
BMD	Bramley-Moore Dock
CC	Climate change
DFE / DFL	Design Flood Event / Level
EA	Environment Agency
FRA	Flood Risk Assessment
LLFA	Lead Local Flood Authority
LCC	Liverpool City Council
m AOD	Metres above Ordnance Datum
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
WFD	Water Framework Directive

Executive Summary

This site-specific Flood Risk Assessment (FRA) has been prepared by BuroHappold Engineering on behalf of Everton Stadium Development Limited (hereafter 'Everton)') as part of a full planning application for the Bramley-Moore Dock Stadium development, hereafter referred to as the 'proposed development'. This assessment has been carried out in accordance with the requirements of the statutory development plan (Liverpool UDP, adopted 2002) and National Planning Policy Framework (NPPF) and considers the potential flood risk to the application site from the following sources: fluvial, tidal, wave overtopping, surface water, sewer, groundwater and artificial sources.

A summary of the key findings of the FRA are provided in the table below.

Subject	Element	Findings
Flood Risk	Fluvial and Tidal	Low risk of tidal and fluvial flooding. High risk of flooding to the majority of the site when climate change is taken into account (2115) based upon existing site levels.
	Wave overtopping	The Mersey River wall protects the west part of the site up to and including a 1 in 100 year and 1 in 2-year event for vehicles and pedestrians respectively under present day conditions. The level of protection decreases to a 1 in 5 year event for vehicles under the climate change condition. Areas along the western boundary are not considered safe for pedestrians during any storm, under climate change conditions. Appropriate on-site management initiatives will be required.
	Surface Water	Low to very low risk of surface water flooding, with localised ponding during the 1 in 1000 year event only.
	Sewers	Low risk of flooding.
	Ground Water	Low risk of flooding.
	Artificial Sources	Low risk of flooding from reservoirs or canals.
Planning	Flood zone	While the EA flood maps for planning put the site in Flood Zones 1, 2 and 3, inspection of the site topography in conjunction with flood level information put the site in Flood Zone 1. This has been formally agreed by the EA at a pre-application scoping meeting in November 2019.
	Vulnerability Classification	The at-grade car parking is considered a 'water compatible' use, appropriate in Flood Zones 1, 2 and 3a subject to a management plan. The electric substation (transformers and switch room) is considered 'more vulnerable' and is appropriate in Flood Zones 1 and 2. The football stadium is considered 'less vulnerable' use, appropriate in Flood Zones 1, 2 and 3a.
	Sequential and Exception Tests	An Alternative Sites Assessment ('ASA') has been undertaken by CBRE Limited (planning consultants) covering the City of Liverpool administrative boundary and parts of South Sefton. As the application site is in Flood Zone 1, the exception test is not required.
Mitigation measures	Design Flood Event	1 in 200 year still water level with climate change allowance.
	Climate change	2115 epoch (95 years climate change, as agreed through pre-application consultation with the EA).
	Finished Floor Levels	Finished Floor Levels of the football stadium are proposed to be set at a minimum of 7.3m based on the 2115 1 in 200 year with 300mm freeboard allowance. The East Stand turnstiles and lift lobbies are set at lower levels to tie in with the existing levels of the exposed Grade II listed BMD walls.

	Residual Risk	The at-grade car parking, eastern Fan Zone plaza, the East Stand turnstiles and lift lobbies of the stadium and parts of the western terrace are proposed at levels under the Design Flood Level (DFL). This is chosen to maintain existing levels for heritage reasons. The proposed uses in these areas are in majority less vulnerable or compatible with flooding. Flood resilient measures have been incorporated where needed.
	Electric substation	The equipment of the electric substation (switch rooms and transformers) is protected from flooding. It is raised internally above the DFL to avoid damage during the Design Flood Event.
	Flood warning and evacuation	A flood warning and emergency plan shall be prepared prior to occupation. The plan will include trigger points aligned with recorded live flood levels and /or rainfall predictions and the actions taken following the trigger points. A plan will be put in place to ensure the safe evacuation of staff and other non-match users.
	Safe access and egress	Safe access and egress for vehicles and pedestrians is provided via the raised access road along the northern boundary of the site.
	Surface water drainage strategy	The drainage strategy will ensure no flooding of the main stadium building for up to the 1 in 100 year event (with allowance for climate change). Minimal flooding occurs at the base of the SE and NE stairwells and lift lobbies of the East Stand for a very short duration. These are set at lower levels due to heritage reasons - to tie in with the Grade II listed BMD walls. Flood resilient measures have been incorporated in the design of these areas to ensure quick recovery. Runoff is discharged to the River Mersey unrestricted via the wider dock network which is under the ownership of Peel Ports and The Mersey Docks & Harbour Company (Peel Land & Property Group was applicant of the approved Liverpool Waters scheme). Downstream defenders are used at every outfall to control water quality.

This FRA demonstrates that with the proposed mitigation measures in place, the proposed development is safe up to and including the 1 in 200 flood event with allowance for climate change and does not increase flood risk elsewhere for the lifetime of the development. A residual risk of tidal flooding and wave overtopping to less vulnerable and water compatible uses is identified and may be adequately managed through a flood warning and evacuation plan.

The proposed scheme is therefore compliant with the provisions of the statutory development plan (adopted Liverpool UDP) and the National Planning Policy Framework (NPPF). There are no flood risk matters which would preclude positive determination of the planning application.

1 Introduction

1.1 Background

This site-specific Flood Risk Assessment (FRA) has been prepared by BuroHappold Engineering on behalf of Everton Stadium Development Limited (hereafter 'Everton') as part of a full planning application for the Bramley-Moore Dock Stadium development, hereafter referred to as the 'proposed development'. This assessment has been carried out in accordance with the requirements of the statutory development plan (Liverpool UDP, adopted 2002) and National Planning Policy Framework (NPPF) and considers the potential flood risk to the application site from the following sources: fluvial, tidal, wave overtopping, surface water, sewer, groundwater and artificial sources.

This report comprises the following sections:

- Section 1 – a description of the site and the proposed development;
- Section 2 – the planning policy context, including:
  - the identification of the relevant flood zone of the site,
  - the proposed development's flood risk vulnerability and its compatibility to the flood zone;
  - consideration of the Sequential Test and Approach;
  - Consultation with relevant bodies;
- Section 3 Appraisal and Management of Flood Risk
- Section 4 Summary and Conclusion

1.2 2020 ES Update

This ES technical appendix relating to flood risk assessment, has been reviewed against the following aspects and for each it has been confirmed that there are no amendments required to the content of the appendix relating to the below points:

- Baseline data validity: there have been no relevant changes to the baseline data;
- Legislation/policy revisions: there have been no related updates to legislation/policy that have affected either the methodology or findings of this assessment;

The planning application (Liverpool City Council application reference 20F/0001) was submitted in December 2019 and has been subject to statutory consultation. There were limited statutory consultee comments received in relation to the information presented in this appendix that required a response. Where relevant, clarification responses have been agreed with the relevant consultees and details are provided in Table 11.2 within ES Volume II, Chapter 11.

Due to the relevance and scale of the proposed development amendments limited technical assessment has been undertaken to confirm the validity of the previous conclusions reported in the Flood Risk Assessment. Specifically, the proposed development amendments impacting the assessment are:

- Removal of the multi-storey carpark (MSCP) and consequent redesign of the western elevation which now includes a stepped area leading to a raised podium. A covered plaza is provided underneath the steps and podium for appropriate access to the west stand turnstiles and hospitality areas;
- Removal of surface car park canopy (PV canopy has been relocated on to the stadium roof); and
- Relocation of Outside Broadcasting (OB) compound and sub-station to the northern extent of the west quay.

The relevant assessment information is discussed within this appendix and therefore this repot has been revised to reflect these updates.

The sections that have been updated are detailed below:

- Section 1.4
- Section 3.1.8
- Section 3.1.9
- Section 3.1.10
- Section 3.1.11
- Section 3.2.2

1.3 Site Description

1.3.1 Site Location

The application site is located at Bramley-Moore Dock (BMD) in Liverpool, National Grid Reference SJ3345292491. BMD forms a small part of a larger dock and canal network along the River Mersey. The outlet to the Leeds and Liverpool canal is approximately 0.5km south of the site into Stanley Dock via Collingwood Dock.

The site is 8.67 hectares and is bounded to the north by the United Utilities waste water treatment plant and Sandon Half Tide Dock, to the east by Regent Road, to the south by Nelson Dock and to the west by the River Mersey wall. The western boundary of the site is limited to the foot of the concrete crown wall, built on top of the River Mersey wall. Figure 1-1 shows the location and red line boundary of the application site.

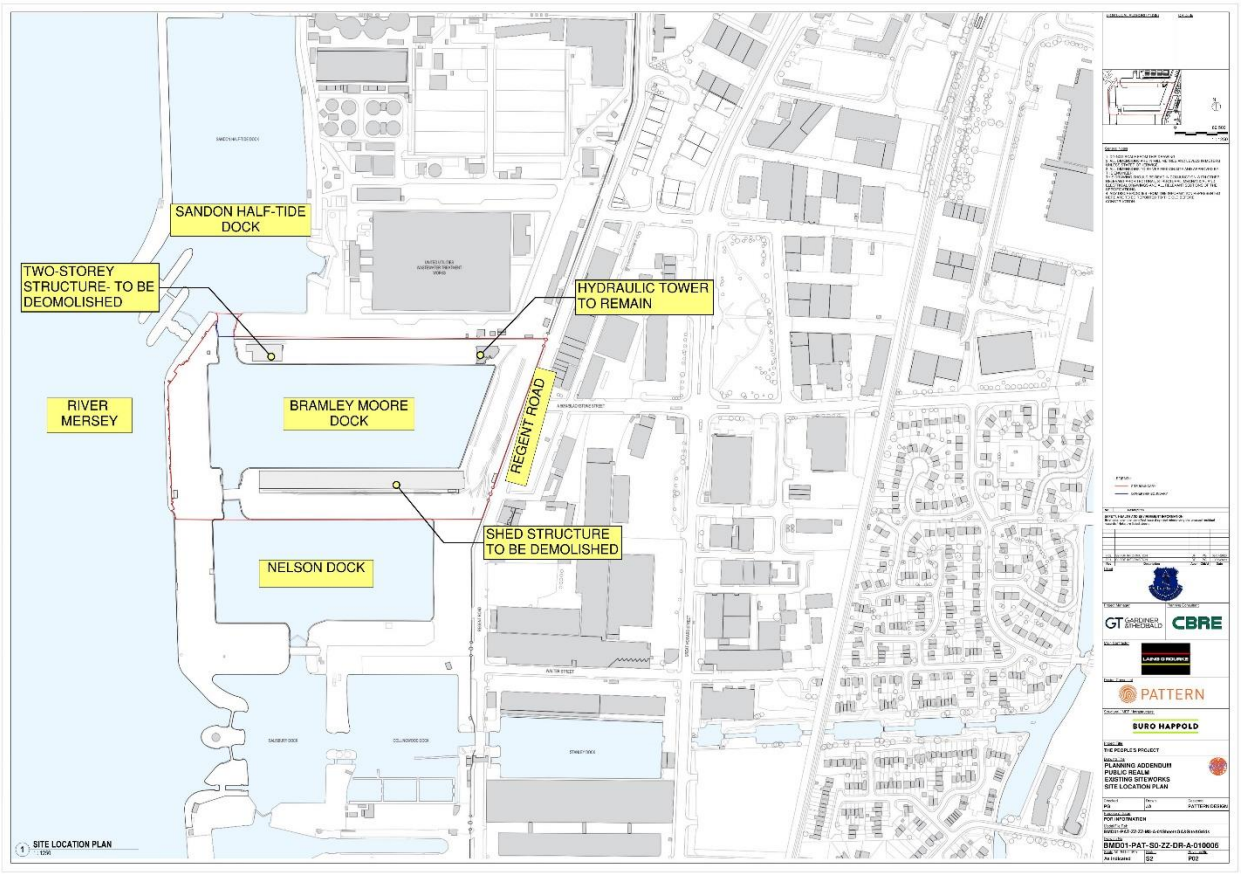


Figure 1-1 Site location plan with indicative site boundary (Background: Pattern Architects)

The application site is currently occupied by a two-storey structure that sits at the western end of the north wharf and a shed structure on the southern wharf. Both structures are unlisted and proposed to be demolished. The Hydraulic Engine House, which is Grade II Listed (referred to as Hydraulic Tower), is located in the northeast corner of the site and is to be retained within the proposed scheme. Other small structures will be demolished as shown in the demolitions plan (and other relevant drawings) prepared by Pattern Architects and submitted with the revised planning application (Liverpool City Council application ref. 20F/0001).

To inform the identification of different dock basins and locks within the FRA an annotated plan of the surrounding docks is provided in Figure 1-2.

Figure 1-2 Dock Plan including red line boundary at Bramley-Moore Dock

1.3.2 Site Levels and Access

BMD is currently accessed through two gated openings in the Grade II listed dock wall from Regent Road, hereafter referred to as Regent Road wall, at the southeast and northeast corners of the site. The two openings on the Regent Road Wall allow vehicular and pedestrian access to the site, as shown in **Figure 1-3**. The top of wall level is 11.26m AOD.

The Regent Road level (bottom of kerb) is 7.1m AOD at the northern access point, and 7.2m AOD at the southern access point. Regent Road continues at a relatively flat-grade to the north and south of the site.

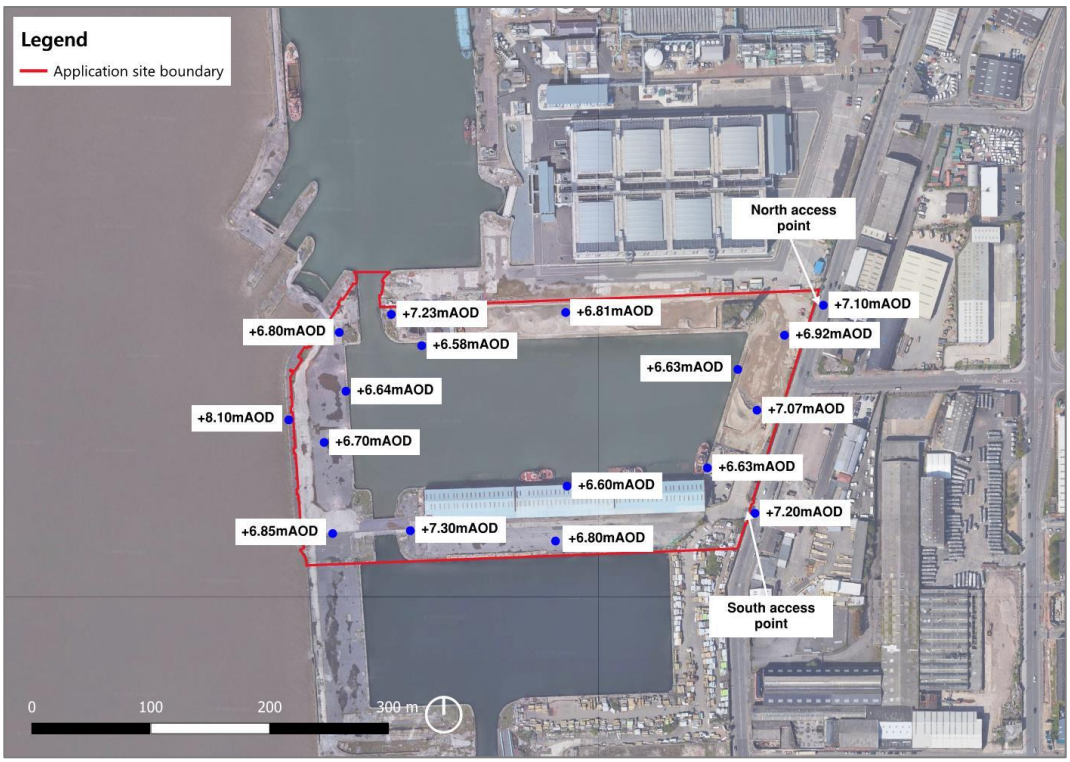


Figure 1-3 Plan with site levels and the two existing access points to the proposed development (Background: *Map data ©2018 Google*)

A topographic survey has been conducted by Murphy Surveys, with the latest update completed on 3rd October 2019. For the topographic survey information please refer to the MEIS drawing included in the main planning information package. Existing ground levels within the application site typically range between 6.6m AOD (top of dock wall level) and 6.8m AOD. Along the eastern edge of the site ground levels rise gradually to meet the Regent Road level of 7.1m AOD to 7.2m AOD.

The retained water level within the dock system is isolated from the tidal River Mersey via a system of lock gates at Langdon Dock, approximately 1.8km to the north. According to the Nelson Dock isolation structure drawing (L24298/01) provided as an appendix to the Liverpool Waters FRA (planning application ref: 10O/2424), the water levels in BMD are understood to be maintained within an operational range of 4.55m AOD and 5.16m AOD.

The water levels within the BMD were also monitored for a short period, between July and September 2017. The levels were found to range between 3.8m AOD and 4.6m AOD, with a mean level of 4.3m AOD indicating the current operational water level range is lower than that stated on drawing L24298/01 described above. It is noted that operational water level is not critical to the flood risk assessments described within this report.

1.3.3 Existing Dock Structures

The BMD basin is surrounded by Grade II Listed masonry dock basin walls (hereafter referred to as the BMD walls). The BMD walls are approximately 10m in height, with a top of wall level of 6.6m AOD and a basin bed (floor) level of approximately -3.4m OD.

Within the northern entrance of BMD, there are existing timber lock gates which are held in the open position to maintain flow and navigation between BMD and Sandon Half-Tide Dock. Further north the two Sandon Half-Tide Dock lock entrances have been blocked off with isolation caisson structures.

There is an existing isolation structure located between BMD and Nelson Dock which is of sheet pile construction. This was constructed in 2007 as part of the Liverpool Canal Link project and enables the water levels within Nelson Dock and the south system to be isolated from water level changes within the northern docks. At 7.5m AOD, the crest level of the structure is higher than the surrounding ground and dock basin wall levels. There are eight 600mm diameter pipes with sluice gates within the isolation structure which provide hydraulic connectivity between north and south when the gates are open.

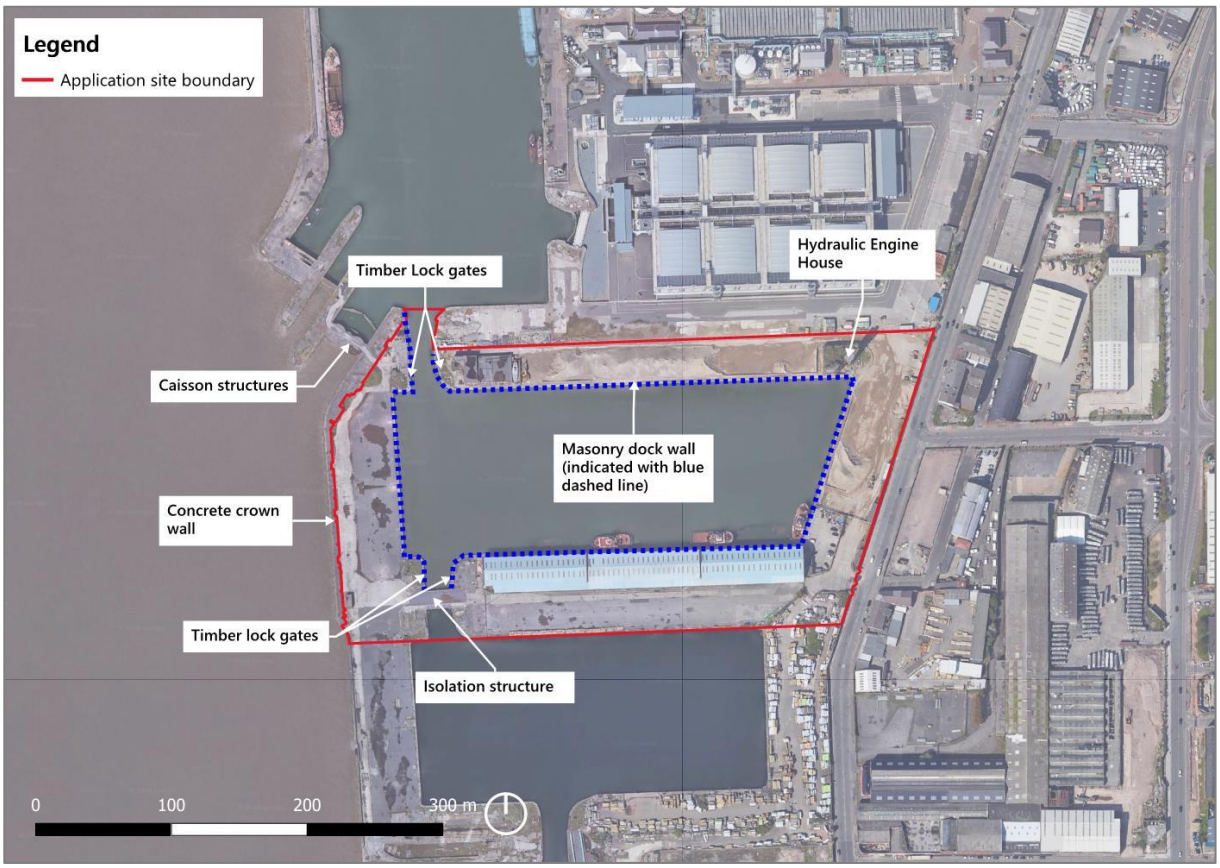


Figure 1-4 Site plan showing the existing dock structures (Background: *Map data ©2018 Google*)

The River Mersey wall runs along the western edge of the site. A concrete crown wall has been constructed above the River Mersey wall with a crest level of 8.12m AOD along most of the application site. This crest is approximately 1.5m higher than the adjacent ground level of the BMD and is outside the red line boundary of the site. This is not classified as a formal flood defence to the site as it is not continuous but will provide local protection against wave overtopping.

The crown wall continues southward beyond Nelson Dock to the entrance to Salisbury Dock. Wall crest levels of 6.6m AOD are present adjacent to the Salisbury Dock isolation structures, representing the local low point to the river boundary. At the northern end of the application site the crown wall crest level rises to 9.4m AOD and continues at this level across the Sandon Half-Tide Dock caisson structures.

1.4 Proposed development

A detailed description of the proposed development is provided in the Planning Statement and Environmental Statement submitted with the full planning application (original planning submission made in December 2019, Liverpool City Council application reference 20F/0001). In summary, the proposed development is for a 52,888 seat capacity stadium with associated facilities and infrastructure.

To enable the proposed development, all buildings will be demolished with the exception of the Grade II listed Hydraulic Tower, which will be retained. The Grade II BMD walls will also be retained and infilled, with a shallow water channel, oriented north to south, to be excavated from the infill on the western side of the dock.

A Fan Zone (public realm area) is proposed to the east of the site between the stadium and Regent Road as shown in **Figure 1-5**. Within the Fan Zone, the existing BMD wall coping will be exposed within the external hard landscaping / public realm works. The Hydraulic Tower will be incorporated into the Fan Zone and potentially used as an exhibition/ cultural centre with a café. Any physical works (internal or external) to the tower will be subject to appropriate listed building consent submissions.

Three additional site access points are proposed through the Regent Road wall to enable pedestrian access to the site via the Fan Zone. The existing northern and southern access points are proposed to be maintained for both pedestrian and vehicular access (subject to appropriate management).

Car parking will be provided on site to cater for both match and non-match days. At-grade car parking is proposed along the western side of the proposed water channel. Access to the at-grade car parking can be achieved via roads passing over the isolation structures, comprising the existing structure to the south and proposed structure to the north.

A Distribution Network Operators compound with switch rooms and transformers (DNO compound) is proposed at the west of the water channel and north of the at-grade car park, adjacent to which a Growlight storage will be provided. An Outside Broadcast (OB) compound is proposed at the north part of the sat-grade car parking. The only facilities provided for the OB compound will be the toilets adjacent to the DNO Compound. Refer to the Plan-It and Pattern Design drawings submitted with the revised planning application.

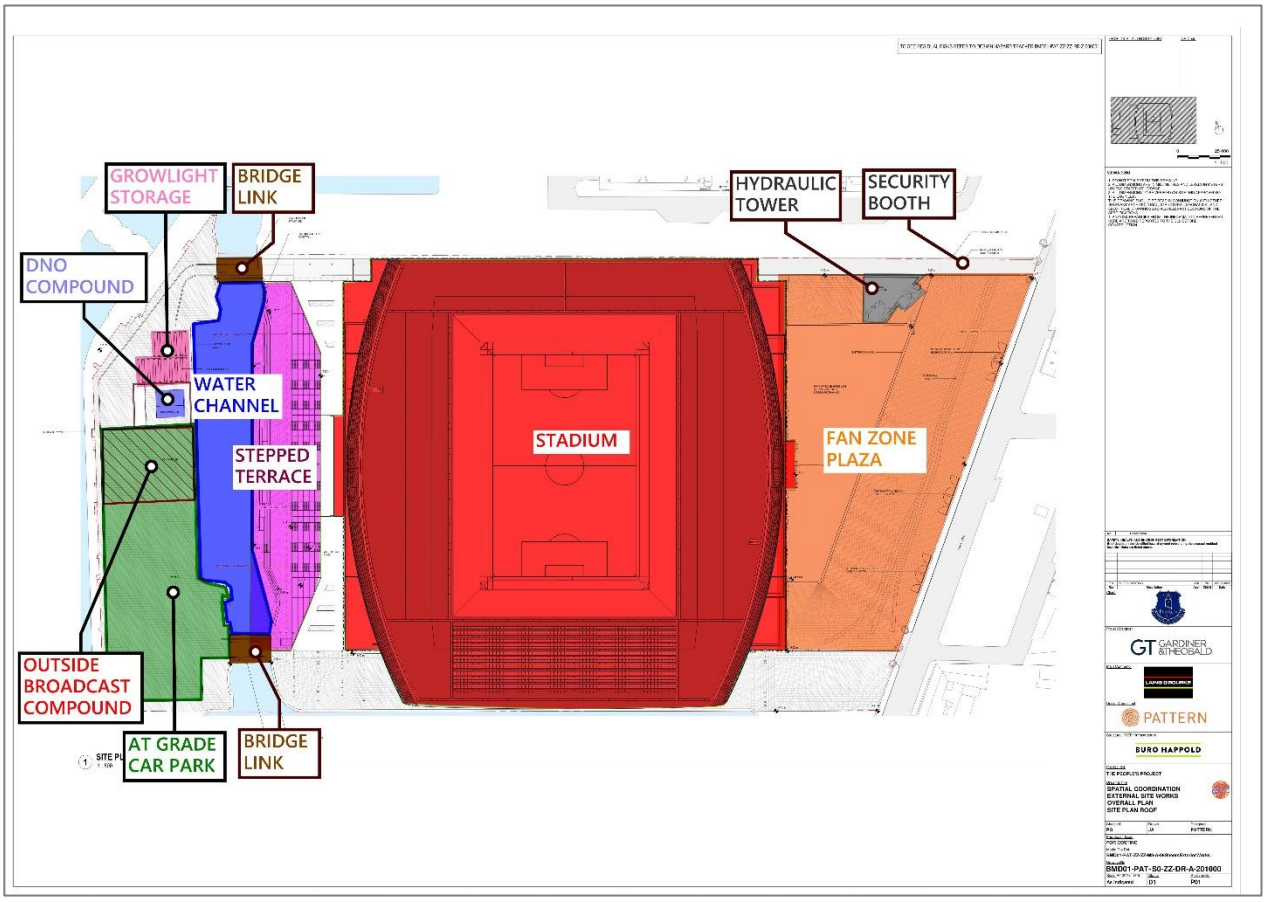


Figure 1-5 Proposed development site location plan (Background: Pattern Architects)

The new water channel, highlighted in blue in Figure 1-5, will provide hydraulic connectivity between Sandon Half-Tide Dock and Nelson Dock. This will be a non-navigable channel with isolation structures at its northern and southern ends. The isolation structure at the southern end is an existing structure as described in Section 1.3.3. Hydraulic connectivity will be achieved via a series of pipes through each structure.

The northern isolation structure is proposed to be constructed between BMD and Sandon Half-Tide Dock. Pipes will be cast in between the two sheet piles at identical levels to the existing southern isolation structure to enable the exchange of dock water to the north and south.

The water channel bed is intended to be at least 0.5m below the bottom of the pipes to ensure any silt build up does not restrict the flow of dock water through the pipes.

A summary of the construction sequence is provided below for general information:

- Northern isolation structure constructed with culverts temporarily capped
- BMD basin infilled followed by stadium construction
- New retaining wall installed through dock infill to form the eastern edge of the new water channel
- Infill material excavated to form the new water channel once the area is no longer required logistically for construction of the West Stand
- Northern isolation structure culverts opened to provide controlled hydraulic connectively between north and south.

1.5 Liverpool Waters – Future Baseline

1.5.1 Liverpool Waters

Peel Land & Property secured outline planning permission (LPA ref. 10O/2424 – latest variation is ref. 19NM/1121) in 2013 for a mixed-use development comprising a maximum of 1,690,000m² of mixed use including 9,000 dwellings and 310,000m² of office space (figures rounded). The site stretches from Princes Dock in the south to Bramley-Moore Dock to the north. The timeframe for full delivery of the scheme at the time of planning application was 2041.

Developments which have been consented at Princes Dock and the Liverpool Waters site since planning approval include the standalone applications: The Lexington (16F/1370 304 apartments), Quay Central and Park Central (17F/1628 2 blocks of 237 apartments), Liverpool Cruise Liner Terminal (17O/3230) and Isle of Man Ferry Terminal (18F/323).

Since planning permission was granted, Peel Land & Property has submitted a series of discharge of conditions applications, reserved matters and non-material amendment applications. A neighbourhood masterplan for the Central Docks has recently been submitted (ref:19DIS/1315) in accordance with the requirements of the planning conditions attached to the outline planning permission. At time of writing this application is still to be determined.

Reserved matters applications have been submitted in the Princes Dock area for the William Jessop House, a 6 storey office development which is in planning terms part of Liverpool Waters (18RM/1554 & 19RM/1817)

1.5.2 Bramley-Moore Dock

It should be noted that the proposed stadium site is located within the Northern Docks (comprising Nelson Dock and Bramley-Moore Dock) proposed in the Liverpool Waters planning application for development to take place between 2036 and 2041 for the following uses:

- C3 Dwellings- 219,500m².
- A1 Retail- 5,000m².
- A2 Financial & Professional services- 300m².
- A3 Food & drink- 2,200m².
- A4 Drinking establishments- 1,200 m².
- B1 Business- 1,800m²
- D1 Non-Residential Institutions- 6,600m².
- D2 Assembly and Leisure-1,000m².

The amount of the development listed above which relates to Bramley-Moore Dock (excluding Nelson Dock) is not specified in the permission, which details the amount of development per Neighbourhood only.

At the outset it should be noted that the proposed stadium use is less vulnerable to flood risk than the approved residential-led scheme for the Liverpool Waters northern neighbourhood. Further information regarding flood risk vulnerability, as classified within the NPPF, is provided within Section 3.1.4 of this report.

2 Planning Context

2.1 Overview

Section 38(6) of the Planning and Compulsory Purchase Act 2004 and Section 70(2) of the Town & Country Planning Act 1990 require that planning applications to be determined in accordance with the statutory development plan, unless material considerations indicate otherwise. The statutory development plan for the City of Liverpool currently comprises the Unitary Development Plan (adopted 2002).

A summary of the statutory development plan policies relevant to the application proposal and matters of flood risk and drainage is set out below. The following policies and guidance are material considerations which also inform the FRA:

- Liverpool Local Plan (Submission Draft, May 2018);
- National Planning Policy Framework (March 2012, updated in February 2019);
- Planning Practice Guidance (March 2014);
- Flood Risk Assessments: climate change allowances (February 2016, updated February 2017);
- Preliminary Flood Risk Assessment Report, Liverpool City Council (June 2011); and
- Strategic Flood Risk Assessment, Liverpool City Council (January 2008).

2.2 Statutory Development Plan (Liverpool UDP, 2002)

Adopted policy EP13 (Flood Prevention) states that unless appropriate alleviation or mitigation measures are carried out, planning permission will not be granted for development which would: be at direct unacceptable risk from flooding; be likely to increase the risk of flooding elsewhere; cause loss of access to watercourses for future maintenance; result in an adverse impact on the water environment due to additional surface water run off; or have adverse effects upon the integrity of tidal and fluvial defences. All works in, under, over or adjacent to water courses, waterbodies and the coast will need to be approved by the Environment Agency's Environmental Appraisal Procedure. Culverting and diversion will not be permitted except to enable reasonable access over a watercourse.

2.3 Material Considerations

2.3.1 Liverpool Local Plan, Submission Draft (May 2018)

A new local plan is presently awaiting formal public examination and when ultimately adopted will replace the Unitary Development Plan (UDP). In accordance with NPPF para. 48, the current submission draft has substantive but not full weight in decision-taking given that it has yet to be formally examined.

In relation to matters of flood risk and drainage, the following draft policies are relevant:

- **Policy STP 2 (Sustainable Growth Principles and Managing Environmental Impacts)** Part K requires developments to Avoid areas at risk of flooding and demonstrate it will not exacerbate potential sources of flood risk

- **Policy R3 (Flood Risk and Water Management)** states that development proposals should protect and enhance water quality, reduce flood risk and include water efficiency measures. All proposals for development must follow the sequential approach to determining the suitability of land for development, directing new development to areas at the lowest risk of flooding and where necessary apply the exception test, as outlined in national planning policy. Developers will be required to demonstrate, where necessary, through an appropriate Flood Risk Assessment (FRA) at the planning application stage, that development proposals will not increase flood risk on site or elsewhere and should seek to reduce the risk of flooding. New development will be required to include or contribute to flood mitigation, compensation and/or protection measures, where necessary, to manage flood risk associated with or caused by the development. Unless appropriate alleviation or mitigation measures are carried out, planning permission will not be granted for development which would:

    A. be at direct unacceptable risk from flooding from all sources, including flooding due to, or exacerbated by, rising groundwater;
    B. be likely to increase the risk of flooding;
    C. cause loss of access to watercourses for future maintenance;
    D. result in an adverse impact on the water environment due to additional surface water run-off; or
    E. have adverse effects upon the integrity of tidal and fluvial defences

    Development proposals should comply with the Water Framework Directive by contributing to the North West River Basin Management Plan and Mersey Estuary Management Plan objectives, by not adversely affecting water quality and should, where possible, seek to improve water quality unless it can be demonstrated that this would not be technically feasible.

    Where reasonably practicable development proposals should incorporate Sustainable Drainage Systems (SUDs) to manage surface water run-off. SUDs should be designed to provide effective drainage; to take account of the likely impacts of climate change and the likely changes in impermeable area; to ensure pollution is controlled; and to enhance water quality and existing habitats and create new habitats where practicable. Proposals for major developments should assess the incorporation of a sustainable drainage scheme into the development at the earliest site-planning stage.

    Proposals should demonstrate that there is adequate wastewater infrastructure and water supply capacity to serve the development. Where it is likely to create a specific shortfall or exacerbate existing deficiencies, developers will be required to adequately mitigate or compensate for those deficiencies, in line with Policies STP4 and STP5.

2.4 National Planning Policy Framework

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which local planning authorities can contribute to the achievement of sustainable development through the respective plan-making and decision-taking processes.

Under Planning and flood risk (paragraphs 155 – 165), the NPPF defines flood risk and aims to avoid development in areas most vulnerable to flooding. This is attained through the implementation of a Sequential Test, which directs development towards areas with lowest flood risk. Where this is not possible, the NPPF requires that all new developments in flood risk areas have followed the sequential approach in locating more vulnerable uses in areas of lowest flood risk, the proposals are appropriately flood resilient and resistant, include safe access and egress routes where required and that residual risks of flooding are adequately managed.

In determining planning applications, NPPF paragraph 163 details that local planning authorities should ensure that flood risk is not increased elsewhere. The NPPF thereafter directs that development should only be allowed in areas at risk of flooding where it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- The development is appropriately flood resistant and resilient;
- It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- Any residual risk can be safely managed; and
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Following on from this, NPPF paragraph 165 details that new major developments should incorporate sustainable drainage systems, unless there is clear evidence that this would be inappropriate. The systems used should take account of advice from the Lead Local Flood Authority (LLFA), have appropriate proposed minimum operational standards, have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development and, where possible, provide multifunctional benefits.

The Planning Practice Guidance provides a number of tables aiding the identification of the degree of risk of flooding to a development. This includes:

- Table 1: Flood Zones definition for probability of river and sea flooding;
- Table 2: Flood risk vulnerability classification for specific land uses and development types; and
- Table 3: Flood risk vulnerability and flood zone compatibility (signifies when the exception test is required).

2.5 Consultations

In accordance with best practice, extensive pre-application consultation has been undertaken with the Environment Agency, Liverpool City Council (as Lead Local Flood Authority – 'LLFA'), Peel Ports and United Utilities as a neighbouring land owner to seek to understand the flood risk of the application site including any historic flood events.

2.5.1 Environment Agency

Buro Happold initiated consultations with the EA early in the design process. Table 2-1 lists the correspondence and meetings held in the past two and half years. All correspondence is included in Appendix A**. The key outcomes from liaison with the EA are summarised in**

Table 2-2.

Table 2-1 - EA consultation summary

Dates	Consultation type	Information
18th May 2017	Email to EA	Submission of pre-application enquiry Request for flood risk related information to EA
1st June 2017	Email from EA	Response to pre-application enquiry Product 4 information
13th June 2017	Meeting with the EA	To discuss and agree the flood risk principles for the proposed development

12th February 2018	Email from EA	Tide data
16th January 2019	Email from EA	Final flood level information for the site with climate change allowances
19th February 2019	Meeting with the EA and LCC	To provide an update to the EA and LCC on proposed development and to agree in principle the flood risk management strategy for the development including minimum development levels
6th November 2019	Meeting with the EA	To discuss the approach to flood zone mapping and wave overtopping assessment

Table 2-2 – Key outcomes from consultations with the EA

Subject	Comment
Historic flood events	EA has no records of flooding affecting the site. United Utilities (UU) and LCC should be approached to provide their records.
Flood extents	The EA provided detailed flood zone maps, as part of their product 4. Updated flood zone maps have been downloaded since the EA product 4 response. The updated maps show large areas of the site within Flood Zone 3 that were previously in Flood Zone 1. During EA consultation on 6th November 2019 it was agreed that BuroHappold should undertake a site-specific assessment of the flood zones using the flood levels provided by the EA in combination with detailed topographic survey data.
Flood levels	EA advised that flood levels should be taken from the Mersey Estuary 2018 Study, which was provided to BuroHappold in January 2019. Data for both the defended and undefended scenarios were provided.
Design Flood Event (DFE) and Design Flood Level (DFL)	The EA has modelled results for up to the 2115 epoch that include allowance for sea level rise. This allows a 95 year design life from construction (2020), which has been agreed as appropriate for the flood protection of the stadium by the EA and Everton Football Club. The Design Flood Event (DFE) is established as the 2115 1 in 200 year flood event and the Design Flood Level (DFL) as the equivalent peak flood level.
Freeboard allowance	EA recommended a minimum of 300mm for the development (commercial and other less vulnerable uses)
Development levels	Stadium: The development levels were agreed to be based on the 2115 1 in 200 (0.5% annual exceedance probability (AEP)) flood levels with 300mm freeboard. Hydraulic Tower: The Hydraulic Tower will be refurbished (to be formalised via separate listed building consent submissions). As the levels are currently under the DFL, flood resilient measures should be incorporated. Kitchen areas should be raised above 7.3m AOD. Car park: Car park will be at-grade below the DFL, as per existing levels. That is acceptable. Lifts and toilets should incorporate flood resilient measures.
Formal flood defences	No formal flood defences at the vicinity of the site.
Breach Modelling	Breach analysis has not been included within the Mersey Estuary 2018 model. No requirement for breach analysis as part of the FRA, as the crown walls are not EA formal flood defences. The FRA conservatively assumes flood levels within the development site are equal to flood levels within the River Mersey.
Wave overtopping	Acknowledgment of the risk of wave overtopping to be included in FRA. The design of the at-grade car park should take into account wave overtopping.
Car parking	EA agreed to the principle of having at-grade car parking, below the design flood level; this is favourable from a heritage perspective to minimise land raising and potential covering of historic features.
Safe access and egress	The EA agreed to the principle of a single raised safe access/egress route, no higher than Regent Road levels, with a flood and evacuation management plan to manage the residual risk.
Water Framework Directive (WFD)	The EA advised that a Water Framework Directive Assessment would be required as part of the application.

2.5.2 United Utilities

United Utilities have been consulted on incidences of sewer and infrastructure flooding in the local area. The information has been reported in **Section 3.4**.

2.5.3 Liverpool City Council (LCC)

LCC as the LLFA is the statutory consultee for surface water flood risk in relation to planning applications. They are the appropriate body to assess the proposed surface water drainage strategy for the development. The LLFA has been approached at an early stage for advice with regard to the site surface water drainage strategy and local flooding (groundwater and surface water). LCC attended the two meetings with the EA on the 13th June 2017 and 19th February 2019 and the main outcomes are summarised below.

Table 2-3 - Key outcomes from consultations with LCC

Subject	Comment
Building proposals	Avoid raising the site above what is necessary for flood risk to avoid losing heritage context.
Surface water flooding	The Liverpool Integrated Model for surface water flooding for the 1 in 30 year and 1 in 100 year events can be provided for the site. These are considered to be more accurate than the maps published by the EA on their website. A copy was forwarded to BuroHappold following the meeting.
Surface water run-off	No flooding of site for the 1 in 30 event. Ponding and storage on site for the 1 in 100 year event is acceptable.
Wave overtopping	Allowance should be made in the drainage strategy for wave overtopping.

Correspondence with the LCC is included in **Appendix A**.

2.5.4 Peel Ports and Peel Land & Property

Peel Ports (including The Mersey Docks & Harbour Company) and Peel Land and Property have ownership of the wider dock network north and south of the BMD. Peel were consulted on 16th May 2019 with regard to drainage matters. BuroHappold outlined the proposals for the drainage strategy. The design intent is to discharge the surface water from the proposed development to the water channel at the west of the stadium, which will connect to the wider dock system. Peel has confirmed they have no objection to the proposal on flood risk or surface water drainage matters.

3 Appraisal and management of flood risk

3.1 Fluvial and tidal flood risk

Fluvial flooding occurs when sustained or intense rainfall events increase the flow in rivers causing the water level to rise above the level of the banks and into surrounding areas. Tidal flooding occurs when particularly high tides coincide with storm surges. Storm surges are caused by low atmospheric pressure events resulting in temporary localised raising of sea levels.

3.1.1 EA flood zones

The Flood Zones refer to the probability of river and sea flooding without the inclusion of flood defences, as shown in **Table 3-1.**

Table 3-1 - Flood Zone definition

Flood Zone	Probability	Definition
1	Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding
2	Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding
3a	High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding
3b	The Functional Floodplain	This zone comprises of land where water has to flow or be stored in times of flood.

Figure 3-1 - Environment Agency's flood zone mapping with indicative red line boundary (Flood extents: © *Environment Agency copyright and/or database right 2019. All rights reserved. Background map: Map data ©2019 Google*)

The EA flood zone mapping, as shown in Figure 3-1 indicates the four areas of the application site within flood zones 1 to 3 as follows:

- West wharf: predominantly flood zone 3
- South wharf: predominantly flood zone 2
- East wharf: predominantly flood zone 1, with small areas of flood zone 2
- North wharf: predominantly flood zone 1, with some areas of flood zone 2

It is also noted that the adjacent Regent Road is also shown as Flood Zone 1.

3.1.2 Flood levels

In January 2019, BuroHappold received updated flood level information from the EA's Mersey Estuary 2018 Study. The EA has advised that the flood levels provided under the 2018 study should be used to set Finished Floor Levels (FFL).

The Mersey Estuary 2018 Study Flood Levels are provided in **Table 3-2** for the two nearest model nodes to the site for both the defended and undefended scenarios. It is noted that there is no difference between the levels for the defended and undefended scenarios. The flood levels are still water levels within the River Mersey. The application site is located between the two model nodes at which flood level data has been extracted from the Mersey Estuary 2018 Study. The upstream MEST_2750 flood levels have been adopted for the site, as agreed with the EA, and are shown in **Table 3-2** below.

Table 3-2 –Mersey Estuary 2018 Study Flood Levels

Model Node Reference	Coords	Data	Defended			Undefended	
			1% AEP (1 in 100yr)	0.5% AEP (1 in 200yr)	0.1% AEP (1 in 1000yr)	0.5% AEP (1 in 200yr)	0.1% AEP (1 in 1000yr)
MEST_2750	E 332641 N 392301	Water Level (mAOD)	6.15	6.26	6.48	6.26	6.48

3.1.3 Site-specific flood zone assessment

Inspection of the site-specific topographic survey data and the flood level data listed above indicates that the EA flood zone mapping overestimates the level of flood risk at the application site. This discrepancy was raised with the EA during a consultation meeting on the 6th November 2019. It was agreed that the most likely reason for the discrepancy is the variation in survey accuracy between the Lidar topographic data used in the EA modelling process (lower accuracy) and the site-specific topographic survey (higher accuracy). It was agreed that a site-specific flood zone assessment was appropriate using the site specific topographic survey.

According to the flood level data provided by the EA (Table 3-2), the flood levels during the 1 in 200 year flood event (Flood Zone 3) are expected to be 6.26m AOD, while the flood levels during the 1 in 1000 year flood event (Flood Zone 2) are expected to be 6.48m AOD.

The site-specific topographic survey indicates that existing ground levels generally vary between 6.6m AOD and 7.3mAOD throughout the application site. There is a very small area in the northwest corner of the application site within which levels drop as low as 6.46mAOD, this is however surrounded by higher levels. **On this basis the application site is deemed to be in Flood Zone 1.** This is considered to supersede the flood zoning described in Section 3.1.1 above.

3.1.4 Flood risk vulnerability

Table 2 of the Planning Practice Guidance classifies development for shops, cafes, assembly and leisure as '*less vulnerable development*'. The stadium and uses within it are considered to fall within this category.

The DNO compound consists of transformers and switch rooms and is essential utility infrastructure to the functioning of the stadium. However, a possible failure of the DNO would impact the site only. In addition to this the site will have a third supply which will be the battery storage /generator to ensure the operational use of the stadium when in match continuation mode. This will provide autonomy for 3 hours. On this basis the DNO compound is not considered *'essential infrastructure'* under the NPPF definition, but *'more vulnerable development'*. The DNO compound is proposed at the northwest of the application site (north of the at-grade car park). Adjacent to that, a Growlight storage area with toilets is proposed. This is considered a *'less vulnerable'* use.

Car parks are not specifically defined within the NPPF vulnerability classification. The open at-grade car park at the west of the water channel and the western terrace public realm are considered *'water compatible development'*.

3.1.5 Flood zone compatibility

For each Flood Zone and flood risk vulnerability classification, the NPPF categorises where development is appropriate and whether the Exception Test is required. The Exception Test is a method used to demonstrate how flood risk to people and property will be managed satisfactorily, while allowing necessary development to proceed when suitable sites with lower risk of flooding are not available. It is required for the proposed development to show that wider sustainability benefits, which outweigh the flood risk, will be provided to the community. It must also be shown that the development will be safe for its lifetime without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

Table 3-3 - Flood risk vulnerability and flood zone 'compatibility'

Flood Zone classification		**More vulnerable – DNO compound**	**Less vulnerable – Stadium**	**Water-compatible – At-grade car park and western terrace**
Flood Zones	FZ1	Compatible	Compatible	Compatible
	FZ2	Compatible	Compatible	Compatible
	FZ3a	Compatible – Exception Test Required	Compatible	Compatible

The entire site is considered to be within the current Flood Zone 1; the proposed uses are considered compatible with the flood risk classification. Based on the compatibility criteria and the appropriate siting of the proposed uses, the exception test is not required for this planning application.

3.1.6 Sequential test

The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding (NPPF, paragraph 157). This general approach is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk.

An Alternative Sites Assessment (ASA) has been undertaken by CBRE Limited to assess the potential for alternative sites to accommodate a new stadium development. The ASA provides a comprehensive assessment of alternative site options within a practical, feasible and realistic catchment area for Everton; assessing the suitability of each site for a new stadium development based on a comprehensive set of assessment criteria. The ASA considers three areas of search: Everton's preferred area of search in "North Liverpool" (which comprises the Wards of County, Anfield, Everton and Kirkdale), an area of "Extended North Liverpool" (within the administrative boundary of Liverpool City Council to the north of the M62 / Edge Lane and part of South Sefton) and a "Wider Area of Search" which included sites within the wider LCC administrative boundary, including South Liverpool (which has been considered following discussions with Historic England). The site assessment criteria includes an assessment flood risk using the EA's flood zone classification.

The ASA considered 50 sites and demonstrates that there are no alternative sites within the wider area of search that are considered to be a feasible, practical or realistic proposition for the Club. The full ASA and the associated site proformas are included as part of the planning submission for BMD.

3.1.7 Climate change allowance

Allowances for the predicted effects of climate change should be taken into account when preparing site-specific flood risk assessments. In addition to the data provided in **Table 3-2**, the EA also provided predicted flood levels for 2065 and 2115, accounting for sea level rise (SLR), as shown in **Table 3-4**. It has been agreed with the EA that the Design Flood Event (DFE) for the site is the 2115 1 in 200 year flood event.

Table 3-4 – Design Flood Levels based on the present water levels with latest climate change calculations

Data	Design Life	0.5% AEP (1 in 200yr)	0.1% AEP (1 in 1000yr)
Water Level – 2016 (mAOD)	-	6.26	6.48
Flood Level – 2065 (mAOD)	45 year	6.58	N/A
Design Flood Level – 2115 (mAOD)	95 year	**6.97**	N/A

With existing site levels generally above 6.58mAOD, large areas of the application site will be free from flooding during the 1 in 200 year event (Flood Zone 3) up to 2065. The vast majority of the site would move into Flood Zone 3 by 2115 (i.e. high risk of flooding), assuming no benefit from existing or proposed defences. Regent Road existing levels range between 7.0 – 7.2m AOD; access in and out of the site would therefore remain free from flooding in 2115.

3.1.8 Development levels and mitigation measures

During the 19th February 2019 pre-application meeting, the EA were consulted on the flood risk management approach described below. The EA were in agreement with the approach as recorded in the meeting minutes appended within Appendix A.

FAN ZONE

The Fan Zone includes heritage structures, such as the Grade II listed BMD walls (to be part exposed as part of the public realm) and the Grade II listed Hydraulic Tower. Areas of the Fan Zone will be set to meet existing levels (approximately 6.6mAOD) to tie in with the historic listed BMD walls. Flooding is not anticipated during the 2065 1 in 200 year event. Flood depths of up to 370mm are predicted during the 2115 1 in 200 year event, with average approximate levels at 350mm. It is proposed that any event at the stadium would be cancelled in advance of such an extreme flood event following a flood warning (refer to section 3.1.10).

STADIUM LEVELS

The development platform for the stadium is proposed to be raised above the 2115 1 in 200 year still water level which is defined as the Design Flood Level (DFL) with a minimum of 300mm freeboard, as agreed with the EA. The stadium level has therefore been set to 7.3m AOD, allowing more than 300mm freeboard from the DFL (6.97m AOD).

The pitch levels are designed to be sloping to allow quick drainage of surface water. The minimum pitch levels are set at 7.3m AOD.

ENTRANCE STAIRWELLS AND LIFT LOBBIES

There are stairwells and lift lobbies that allow access to the upper concourses at the four corners of the stadium. While the SW and NW entrances are set at minimum 7.3m AOD as with the rest of the stadium areas, the SE and NE stairwells and lift lobbies within the East Stand are proposed at 6.6m AOD to tie in with the existing levels of the exposed Grade II listed BMD walls. Ensuring the BMD walls are exposed and visible within the fan zone plaza is a key heritage design feature.

Due to the constraint imposed by the existing level of the BMD walls, the SE and NE stairwells and lift lobbies are exposed to tidal flooding during the 2115 1 in 200 year flood event. The expected depth of flooding within this area is approximately 370mm. While these areas are within the apron of the building, these are unheated spaces that are partly exposed to wind and rain due to the permeability of the façade i.e. 'open to the external environment'. The internal walls within these areas will therefore be designed to withstand these elements and ensure no water ingress to the main building.

Any event at the stadium would be cancelled in advance of the 1 in 200 year event following a flood warning. Flood resistant or resilient measures such as raising electric equipment/sockets above the 7.3m AOD level and using finishes that are water resilient and have good drying and cleaning properties will be integrated into the design of the ground floor of the SE and NE stairwells and lift lobby during technical design post-planning. The design of the structure will account for additional water pressure to the building due to extreme tidal levels. Sump pits will be included in the lift shafts to pump floodwater to local drains following the event and once water levels have receded.

Safe access and egress from the stadium during the 2115 1 in 200 year flood event for any staff or visitors will be provided via the SW and NW entrances, utilising the raised northern access road to reach Regent Road. Please refer to Section 3.1.11.

HYDRAULIC TOWER

The Hydraulic Tower will be refurbished (via separate listed building consent submissions) and retained at existing levels (approx. 6.6m AOD). It is proposed to accommodate an exhibition/cultural centre along with an ancillary café which will need to be raised above the DFL with a 300mm freeboard where possible. Flood resilient and resistant measures will be implemented below 7.3m AOD.

AT-GRADE CAR PARK

At-grade car parking is proposed along the west boundary of the site, west of the proposed water channel. The general levels are similar to existing and are approximately 6.6m AOD. During the DFE the area will be inundated with water to an average depth of 350mm, with resulting localised ponding of up to 470mm along the stormwater drains. It is proposed that car charging points will be located within the at-grade car park. Mitigation measures will be put in place to ensure the equipment is protected from water inundation. These could include raising of sensitive equipment above the floodplain either on plinths or on the supporting structure of the canopy. Use of this car park will be restricted following a flood warning (in association with extreme tidal flooding).

OB COMPOUND AND EQUIPMENT

The OB compound consists of an open area where the Outside Broadcast vehicles are parked leading up to and during match days. This is part of the at-grade car park. It also consists of the OB kiosk and buried ducts with OB cabling running from the OB kiosk (located adjacent to the DNO compound) to the north of the stadium. The OB kiosk will be raised to 7.3m AOD to protect it from flood inundation. The OB chamber at the interface with the stadium structure is located at the north part of the stadium along northern road and is set at 7.3m AOD.

A substation is located adjacent to the OB kiosk. The substation is raised to 7.3m AOD.

The toilet block adjacent to the OB Compound is connected to the main foul network via a pump. The toilet flood levels are raised to 7.0m AOD, with the toilet seat level set above 7.3m AOD) to restrict flood water entering the system.

DNO COMPOUND

The DNO compound will remain at the existing level of approximately 6.8m AOD. The transformers and switch rooms within the DNO compound will be locally raised above 7.3m AOD (DFL + 300mm) to remain operational during a flood event and minimise any damage. A slot drain around the base of the concrete plinth will allow drainage of the compound once the tidal flood levels have receded.

GROWLIGHT STORAGE

The Growlight storage area will remain at the existing level of 6.8m AOD. The Growlight storage area is only to be used to store the grow lights when a match / event is occurring. At all other points the grow lights will be within the stadium. The risk of damage to the equipment is therefore considered low.

WESTERN TERRACE

A stepped terrace is proposed to the west of the stadium, between the stadium and the new water channel. The area will include a low-level walkway along the water channel set at 5.6m AOD, with stepped terrace up to approximately 6.85m AOD to a public realm area. The public realm has a shallow slope up to 7.3m AOD to tie in with the stadium entrances. An elevated stepped amenity area provides sheltered access/ egress to the west stand turnstiles and hospitality entrances below. During a tidal flood event, the walkway along the new water channel will be inundated up to 1.4m deep. Parts of the public realm will be flooded by approximately 100mm. No flooding is expected underneath the covered area underneath the elevated steps, as this area is raised above the DFE.

Management of residual flood risk to these areas during an extreme flood event is discussed further in Section 3.1.10. Following a tidal flood event, the area will naturally drain to the water channel once the water levels have receded.

3.1.9 Residual risk – tidal flooding (excluding wave overtopping)

As highlighted in the sections previously, despite the land raising of the stadium, parts of the site are at risk of tidal flooding during the DFE. Areas at risk of inundation are highlighted blue in **Figure 3-2**.

During the DFE, the expected flood levels within the at-grade car park will be, on average, 350mm, with localised flooding of up to 470mm. Parts of the western stepped terrace will be inundated by 100mm, with the water channel walkway inundated by 1.4m deep water. Parts of the Fan Zone east of the stadium should expect flood depths of up to 420mm.

The extended version of Table 13.1 of the Defra report FD2320/TR2 2005 is a simple method to estimate the flood hazard classification to people. It takes into account the depth and velocity of the flood water and applies a debris factor. This does not include allowance for wave overtopping which is considered separately within Section 3.2.

The hazard to people within the at-grade car park and OB area is anticipated to impose on average 'Danger for some' (including children, elderly and the infirm), with some localised deeper areas imposing 'Danger to most' (general public). The hazard to people in the deeper areas of the Fan Zone is believed to be 'Danger for some' (including children, elderly and the infirm). The low-level walkway adjacent to the water channel could impose 'Danger to most' (general public). This estimation is assuming low velocities of flow, due to the wind, wave and flow protection that the River Mersey crown wall provides to the site.

Use of the proposed development should therefore be limited prior and during such an extreme event. Non match-day operations may continue within the Stadium, which is protected from flooding, but events involving large numbers of visitors would be cancelled. A flood management plan shall be prepared prior to occupation of the proposed development to reduce and control flood risk to people and property. The plan shall inform users of the residual risk, include a flood warning and evacuation plan, areas to be avoided during flood events and provide safe access and egress measures as detailed below.

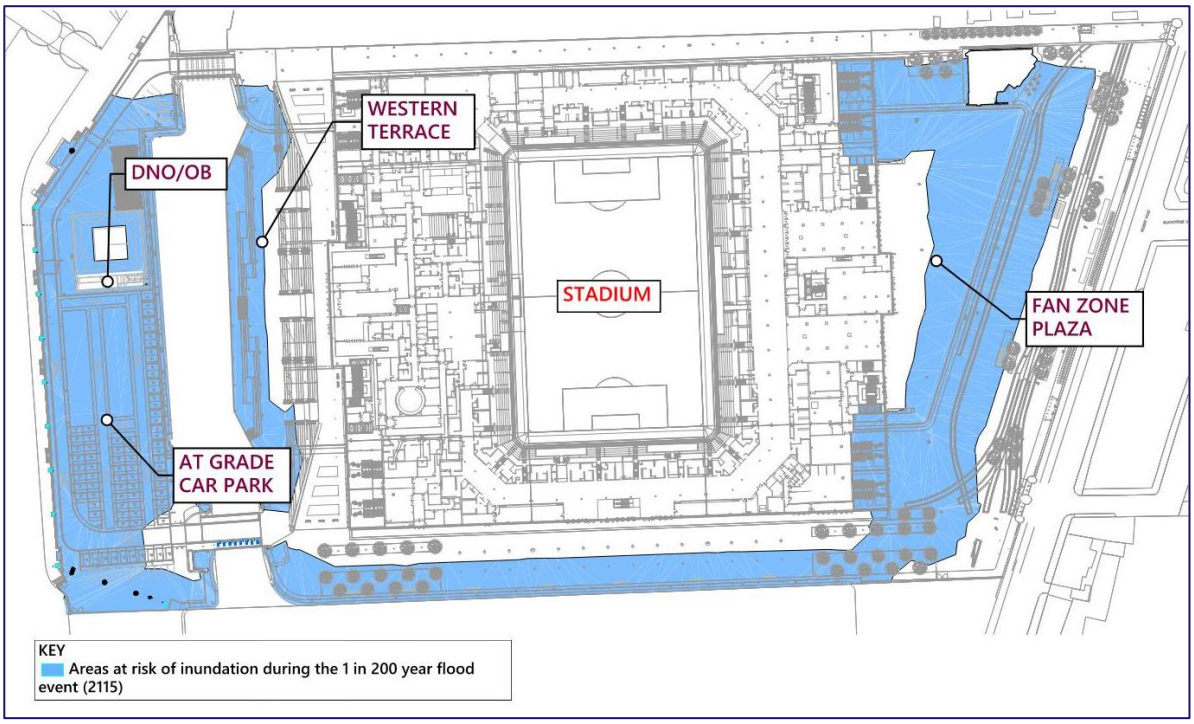


Figure 3-2 - Areas at residual risk of flood inundation during the 1 in 200 year flood event (2115)

Figure 3-2 illustrates the area of inundation and corresponding residual risk during the DFE, being the 1 in 200 year flood event in 2115.

It is noted that the residual risk will be lower during the 1 in 200yr flood event in 2065 due to the reduced sea level rise component. Assessment of the 2065 flood event indicates the residual risk to be very low with areas of inundation limited to the walkway and terraced steps alongside the new water channel. Subject to future consultation (and actual sea level rise) it is possible that a match could be held during such an event in 2065, although flood risks within the wider community may lead to its cancellation.

3.1.10 Flood warning and evacuation

As parts of the application site will be at a residual risk of tidal flooding, a flood warning and evacuation plan shall be put in place prior to occupation to ensure that the stadium and other development is not in use during extreme flood events. The plan will be based on trigger points and thresholds aligned with recorded live flood levels, EA flood warnings and rainfall predictions. This will be developed in consultation with the EA and the LCC emergency team.

The plan will outline the responsibilities and actions of the management authority of the stadium for cancelling matches and events in line with the trigger points set, as well as to manage closure of the lower areas of the site including the at-grade car park, parts of the western terrace and the Fan Zone.

Additional constraints and mitigation measures are listed in Section 3.2 in relation to wave overtopping.

3.1.11 Safe access and egress

In accordance with the flood warning and evacuation plan, the site and especially the inundated areas should be closed off prior to and during a flood event. Access to areas at risk of inundation should be prevented.

A safe access and egress route for the site for vehicles and pedestrians will be provided along the northern boundary of the site. This northern access route is provided at a minimum level of 7.1m AOD to match the level on Regent Road. A route through the stadium at 7.3m AOD will be provided as shown below.

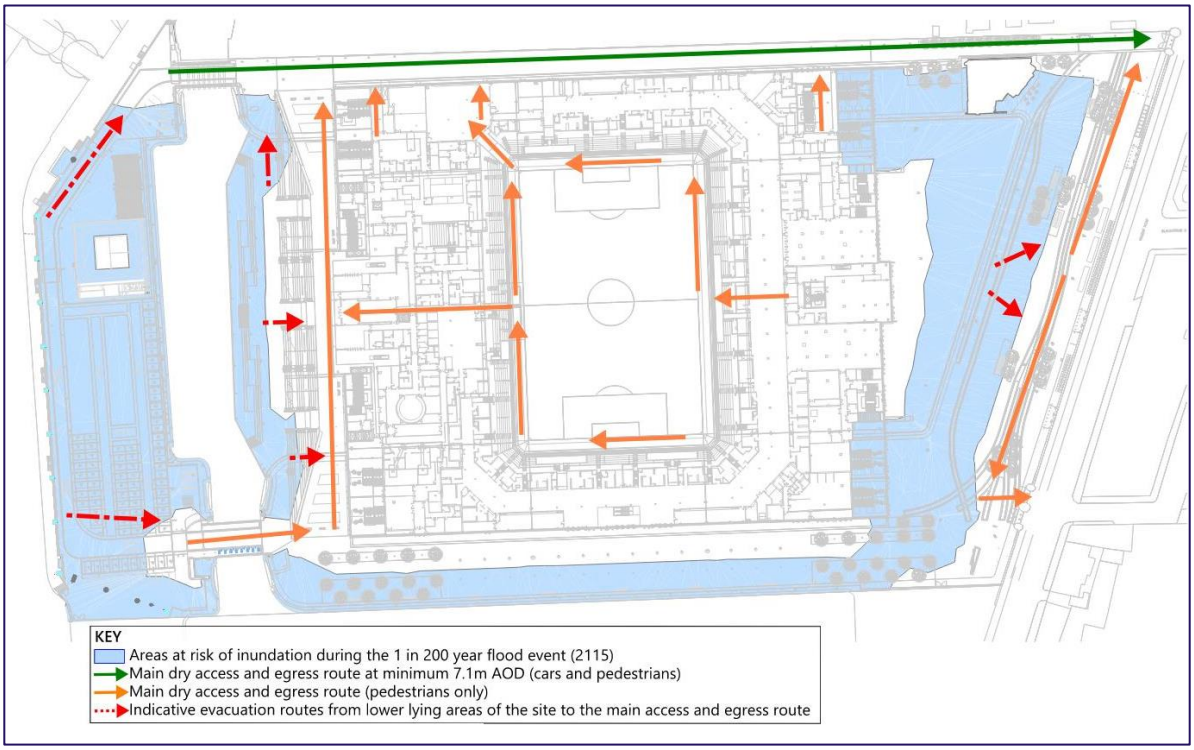


Figure 3-3 - Safe access and egress route

If pedestrians are within the flood risk areas, the quickest routes to higher grounds shall be followed, either through the stadium or via the western terrace to the northern road. The access of anyone to flood risk areas should be strictly controlled, as explained under flood warning and evacuation above.

Access for inspection and maintenance of the River Mersey wall (outside of application boundary) can be achieved via the northern road.

3.2 Wave Overtopping Residual Risk

Wave overtopping can occur due to a combination of a high still water level and waves interacting with and breaking upon a structure such as the river wall or lock entrance isolation structures resulting in water passing over the top of the structure. At the application site these may be swell waves penetrating from the Irish Sea into the River Mersey or wind waves generated locally within the River Mersey estuary.

Using publicly-available extreme water level and wave data from the EA, Coastal Channel Observatory and other sources, a joint probability (JP) analysis has been undertaken to define a range of test scenarios for combined water level and wave height return period events ranging from a 1 in 1 year JP event to a 1 in 200 year JP event for present day and future climate change conditions.

The western front of the River Mersey wall is a simple plain vertical wall and so to determine the magnitude of exposure that the river wall is subjected to, a wave overtopping assessment has been undertaken using the methodology for steep sided and vertical walls described within EurOtop II. As described in earlier sections of the FRA, immediately behind the river wall an at-grade car park, DNO compound containing electricity transformers and a switch room, a storage area for Growlights and an outdoor broadcasting (OB) area is proposed as part of the development. This area will therefore be used by pedestrians and vehicles as well as containing utility infrastructure that have the potential to be affected or damaged during storm events. From EurOtop II the safety limits in Table 3-5 have been defined, above which the area will be considered unsafe.

Table 3-5 - Overtopping Safety Limits for Pedestrian and Vehicles

Wave Height (m)	Pedestrian Limits		Vehicle Limits		Building Limits	
	Mean Discharge, q (l/s/m)	Maximum Volume, V_{max} (l/m)	Mean Discharge, q (l/s/m)	Maximum Volume, V_{max} (l/m)	Mean Discharge, q (l/s/m)	Maximum Volume, V_{max} (l/m)
≤1	10	600	75	2000	1	1,000
2	1	600	10	2000	1	1,000
≥3	0.3	600	5	2000	1	1,000
NOTE: For intermediate values between a 1m and 3m wave height interpolation was used						

3.2.1 Baseline

From the wave overtopping analysis it was found that for present day conditions the western access road will be safe for use up to and including a 1 in 2 year and 1 in 100 year event for pedestrian and vehicles respectively, decreasing to being unsafe for all storms and a 1 in 5 year event for the climate change condition (2115) along the entire length of the river wall.

Two separate assessments have been undertaken for the two sections of the River Mersey wall due to the change in wall orientation and therefore wave condition, namely: the main section of the River Mersey wall and the northern end of the River Mersey wall. Under the present day 1 in 200 year storm event, the mean discharge is predicted to range between 1.37 and 3.14l/s/m with the maximum wave volume ranging between 2,040 and 2,492l/m. For the climate change condition these ranges increase to 10.75 – 28.43l/s/m and 4,719 and 5,570l/m respectively. Across the 220m length of river wall this gives a total predicted discharge of 599l/s for the present day and 5,330l/s for the climate change condition.

A complete record of the wave overtopping analysis of the baseline is contained with **Appendix B**. It is noted that the methodology does not include the use of wave modelling to predict the transmission of waves from the wave buoy to the application site. As a substitute for wave modelling a transmission coefficient has been estimated for different return period events using various reference documents with a 10% increase being applied to the transformed wave heights to account for any uncertainties. A separate 10% allowance has also been added to account for climate change effects. Given that wave overtopping is treated as a residual risk, this methodology is considered to be sufficiently accurate and robust to support the assessment.

3.2.2 Proposed development

Utilising guidance for vertical walls within EurOtop II, the vast majority (>95%) of the overtopped water is expected to land within 15m of the front face of the river wall, the extent of which is shown in Figure 3-4. The immediate impact of wave overtopping is therefore limited to the western most areas of the at-grade car park, DNO compound, Grow Light Storage and OB area; and is not anticipated to affect the rest of the stadium site. Due to the nature of vertical walls, wave overtopping tends to create violent and high energy jets of water that shoot vertically into the air with only a minor horizontal component before falling directly downwards onto the crest of the wall and anything located upon it.

Based upon EurOtop II guidance, Buildings within this 15m zone are at risk of damage during storm events with a return period greater than 1 in 20 years in the present-day case and during most storms of any return period event once sea level rise comes into effect.

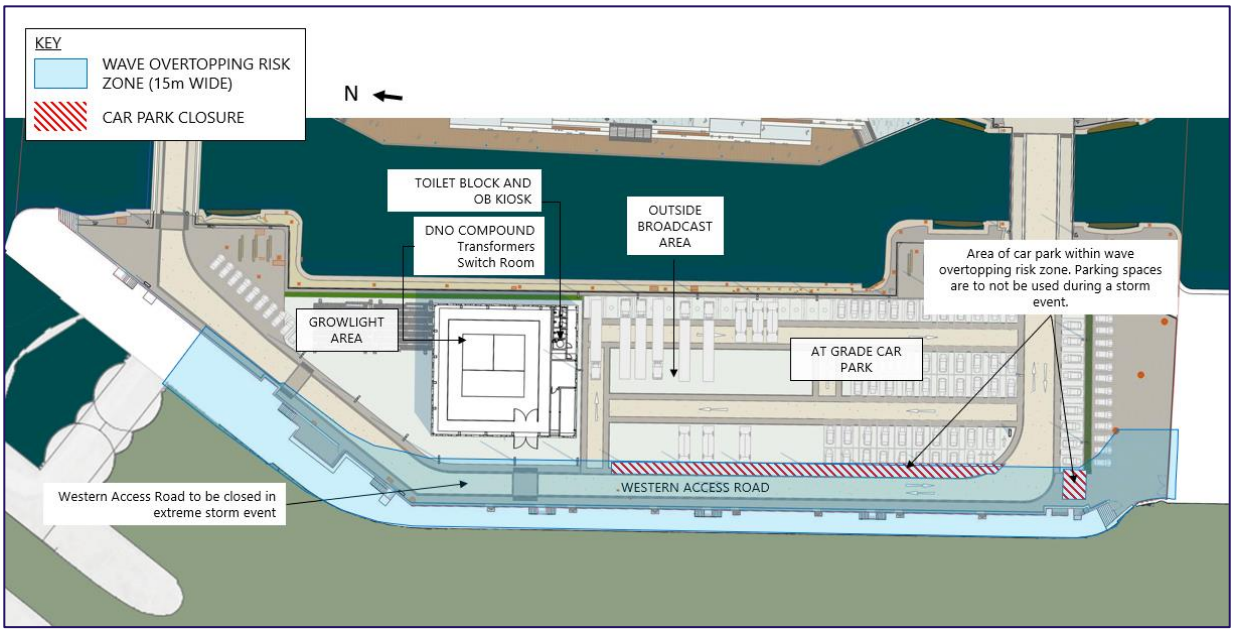


Figure 3-4 - Proposals to manage Overtopped Water coming over the River Mersey wall in a Storm Event

To mitigate the risk that wave overtopping poses to the areas behind the river wall the following measures are recommended for implementation:

WESTERN ACCESS ROAD AND RIVER MERSEY WALL

- The Western access road should be closed to all pedestrians during all storm events due to the high vulnerability of this user class to overtopping waves (see Section 3.2.3 on Safe Access and Egress).
- The Western access road should be closed to vehicle access during extreme flood events larger than a 1 in 5 year event with climate change.

AT-GRADE CAR PARK

- During a storm event the car parking spaces within 15m of the front face of the River Mersey wall should be closed and not used.
- All charging points for electrical vehicles are to be located outside the wave overtopping risk zone with sensitive equipment raised above +7.3mOD to protect them from tidal flooding.
- Equipment should be selected to minimise the risk of corrosion due to saltwater exposure.

DNO COMPOUND/ OB KIOSK

- The DNO compound, OB kiosk and toilet facilities are located outside the 15m wave overtopping risk zone.
- Only formed of a perimeter wall, wave overtopping water has the potential to enter the DNO compound through openings in the walls and door.
- The DNO equipment (transformers and switch room) and the OB kiosk will be raised above 7.3m AOD to protect them from tidal flooding. This will also protect them from water associated with wave overtopping that may penetrate the compound.
- Drainage is provided within the internal walls of the DNO compound between the compound wall and the transformers and switch room plinth to drain away the overtopped water.
- Primary access into the compound is provided along the western wall of the compound. This point of access is outside the 15m wave overtopping risk zone.
- Equipment should be selected to minimise the risk of corrosion due to saltwater exposure.

GROWLIGHT STORAGE

- Only formed of a perimeter fence, wave overtopping water has the potential to enter the Growlight storage area through the security fence.
- The grow light storage area is only to be used to store the grow lights when a match / event is occurring. At all other points the grow lights will be within the stadium. The risk of damage to the equipment is therefore considered low.
- Drainage is provided within the storage area to drain away the overtopped water.

OB AREA

- Vehicles using the OB area should be prevented from parking within the 15m wave risk zone during a storm event.

Given the volume and velocity of the water predicted to overtop the River Mersey wall it has the potential to penetrate further than the 15m zone once it lands on the ground behind the river wall due to the impermeable surfaces being used. A large portion of this overtopped water will be able to be captured by the proposed surface water drainage systems being installed for the at-grade car park and surrounding areas. In the event that a part of the drainage system becomes blocked or exceeded, the proposed surface levels will allow the water to drain to the new water channel to the west of the stadium. The proposed surface levels will not allow ponding deeper than 250mm.

3.2.3 Safe access and egress

Although measures have been put into place to manage flood risk, the area behind the Mersey River wall will remain unsafe to pedestrians and vehicles in the more extreme storm events (all storms for pedestrians and >1 in 5 year event for vehicles in the climate change case).

The type of wave overtopping at vertical walls results is violent, high energy wave breaking that can pose a serious risk to life due to the high velocity water jets that are created. For this reason, it is recommended that if an EA flood warning is issued, access across the link bridges by members of the public is prevented during the lead up to and during a storm event. Access to the area by vehicle may be permitted for stadium staff and other contractors who have been made aware of the overtopping risk provided that they do not use the Western access road in the lead up to and during a storm event. Access to the OB compound should be temporarily permitted from the southern access road, rather than the normal route of accessing from the north.

3.3 Flooding from Surface Water

Surface water flooding occurs when intense rainfall is unable to naturally soak into the ground due to impermeable ground covering such as concrete or tarmac, or low permeability ground conditions preventing infiltration. This excess surface water can flow through built-up areas and open space, and, pond in lower-lying areas causing localised flooding. This type of flooding is associated with short-duration, heavy downpours of rain.

3.3.1 Baseline

The Liverpool Integrated Model surface water flood map (see Figure 3-5) was provided by the LCC following consultations in February 2019. The map is considered more accurate than the EA flood maps and shows that there is a low flood risk from surface water within or at the vicinity of the application site. The flood maps do not take into account the effects of climate change.

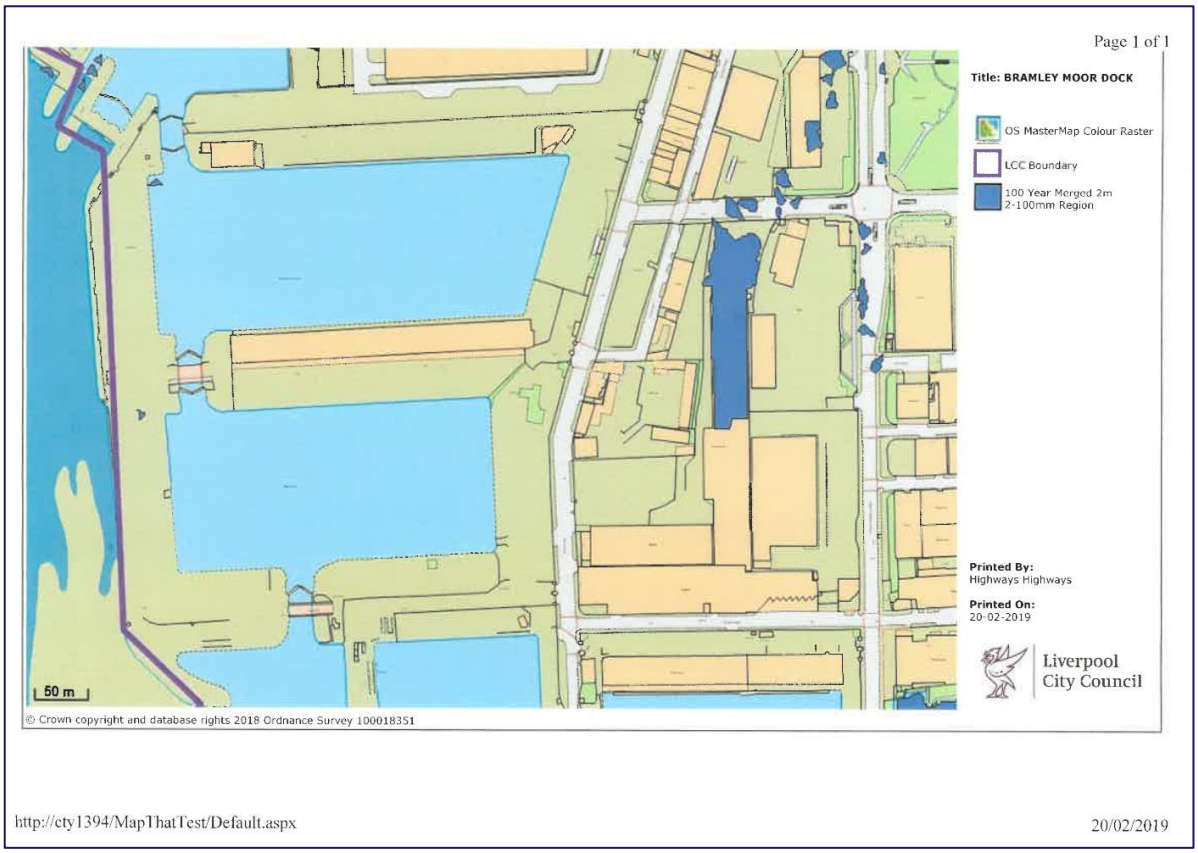


Figure 3-5 - Surface water flood extents map for the 1 in 100 year flood event (Liverpool Integrated Model, provided by LCC on 20/02/2019)

Information on higher order events such as the 1 in 1000 year even, can be attained from the EA's flood maps for surface water flooding. As shown in Figure 3-6, there are areas adjacent to the site shown to be at low risk from surface water flooding (1 in 1000 year event). These areas include Regent Road immediately outside the site with depths predicted to be less than 300mm. Considering the low flood levels, it is anticipated that access to and from the site can be attained safely via Regent Road during up to the 1 in 1000 year surface water flood event.

The surface water flood risk at the application site is considered *low* to *very low*.

Figure 3-6 - Environment Agency's surface water flood extents map for the 1 in 1000 year flood event (EA, 29/10/2019)

3.3.2 Proposed development

The proposed development will be served by a new surface water drainage system designed in accordance with current best practice to collect and convey water away from the development in a safe and controlled manner. Refer to the Drainage Strategy submitted as part of the Planning Application for more information and plans outlining the drainage strategy for the proposed development.

The drainage system has been designed for the 1 in 2 year event while it provides adequate capacity so as not to surcharge for the critical 1 in 30 year storm event. Floodwater generated for up to the critical 1 in 100 year storm event with allowance for climate change (40%) will be contained within controlled areas on site so not to cause damage to buildings, essential services or adjoining developments and services. The hard landscaped areas around the site are inclined away from the Stadium and towards surrounding areas; during exceedance events, surface water runoff will drain safely to Nelson Dock on the south of the site or the new water channel west of the stadium. Refer to **Figure 3-7** for a plan showing the controlled areas of ponding during the 1 in 100 year flood event with 40% climate change.

Some surface water flooding is expected to occur within the East Stand turnstiles and lift lobby of the stadium. This is estimated to be up to only 10mm. Water will only ever enter these areas during a 15 or 30min duration 1 in 100 year (+40% climate change) storm event. As described in Section 3.1.8, these areas are 'open to the external environment' and the internal walls within these areas will therefore be designed to withstand these elements and ensure no water ingress to the main building. Gullies can be provided in the stairwells to drain the flood flows and sump pits will be provided within the lift pits to allow flood water to be pumped out after the storm event. More information on the expected depth of ponding around the site can be found in Appendix 11.4 of the ES chapter: Drainage Strategy.

The design of the surface water drainage strategy follows the hierarchy of drainage solutions, as recommended by the CIRIA Guidance C753. Discharge to the ground via infiltration is not possible due to the historic nature of the site and retention of harbour walls. Following discussion with the EA, it has been agreed that the surface water can be discharged to River Mersey via the wider dock network controlled by Peel Ports unrestricted. This is common practice for developments adjacent to tidally influenced rivers, especially when located at the downstream end of the river catchment. Drainage through the wider dock network has been agreed with Peel Ports during a meeting on 22nd October 2019.

Sustainable Drainage Systems (SuDS) will be implemented where possible to enable water quality control of the surface water runoff. An assessment has been undertaken on the applicability of different SuDS solutions for the site. Not all SuDS systems are appropriate for the application site. Surface water runoff from all areas will be treated via downstream defenders at all outfalls before discharge to the new water channel. The water channel is linked to the wider dock network. Refer to the Drainage Strategy submitted as part of the Planning Application for more information and plans outlining the drainage strategy for the proposed development.

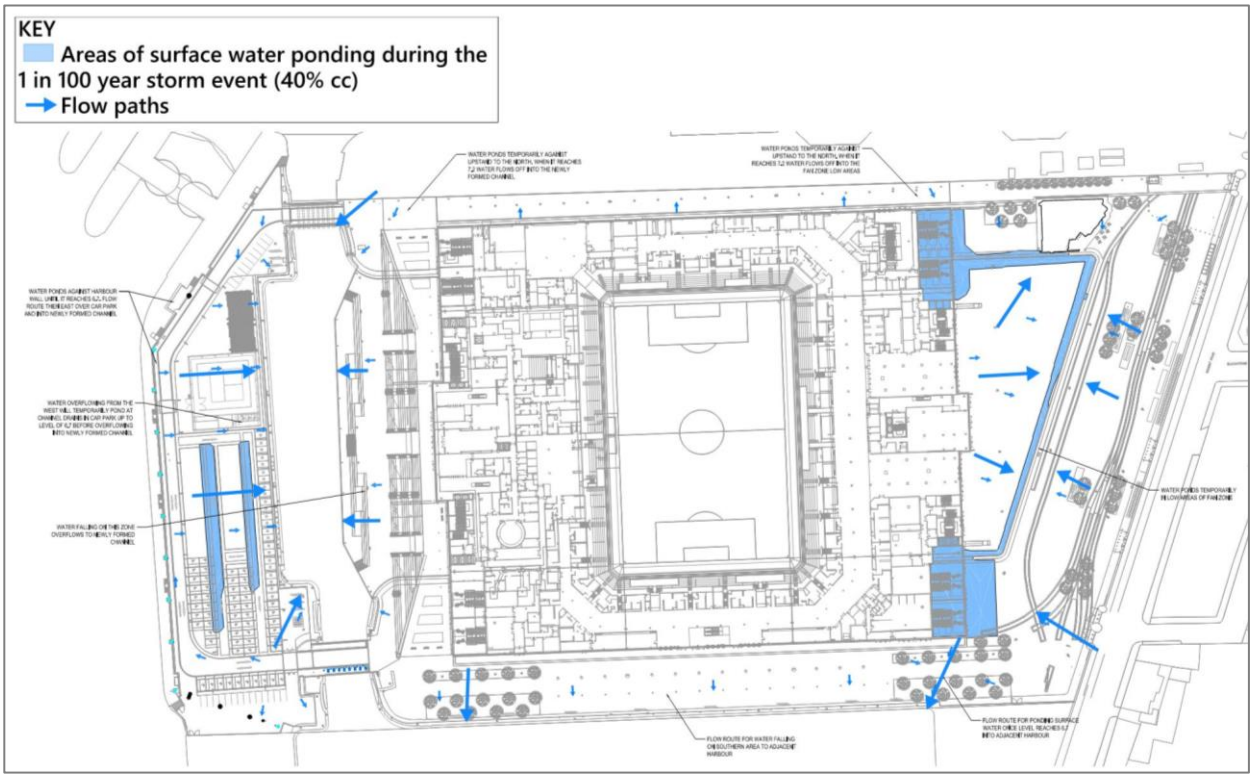


Figure 3-7 - Proposed surface water drainage system (areas of ponding during the 1 in 100 year storm event and climate change are shown in blue, drainage flow paths shown in purple arrows, stadium roof shown in orange).

There is a residual risk of surface water flooding due to above ground attenuation provided in the Fan Zone as shown in Figure 3-7. This attenuation is only required during the 1 in 100 year storm event. It is considered that the risk of surface water flooding to the site is therefore *medium*. The anticipated water depth is less than 80mm. The hazard to people is considered very low although pedestrians should be cautious (FD2320/TR2, DEFRA 2005).

3.4 Flooding from Sewers

Flooding from sewer and infrastructure failure can be caused by several factors: the capacity of the system is exceeded in large rainfall events; the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse; or, a large water supply main can rupture and inundate the local drainage network.

United Utilities have been consulted on incidences of sewer and infrastructure flooding in the local area. The sewer networks surrounding the site are generally combined systems, where both rain water and foul effluent drain to the same pipes. This means rain water runoff becomes contaminated and needs to be treated prior to disposal. A large upgrade of the sewer systems in the area was completed in 1989, including construction of the United Utilities Wastewater Treatment Works and the Mersey Estuary Pollution Alleviation Scheme (MEPAS) Tunnel that runs beneath Regent Road. The latter provides a large volume of storage to retain the runoff from large rainfall events and allow its treatment at the Sandon Dock works prior to discharge to the River Mersey. Refer to **Figure 3-8** for the United Utilities assets map.

The Wastewater Treatment Works were extended as part of an investment to achieve the water quality standards required under the Water Framework Directive; a new sequential batch reactor and other facilities have been constructed in the reclaimed Wellington Dock in 2016, north of the application site (application site shown in red below).

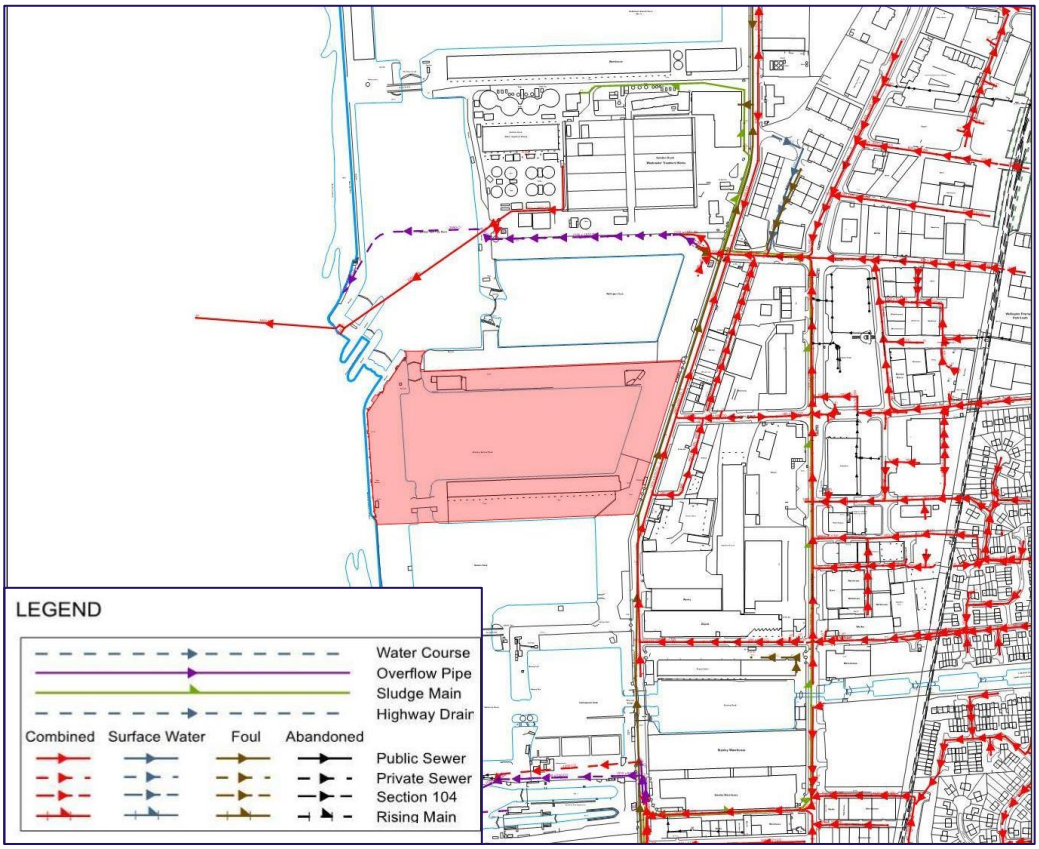


Figure 3-8 - United Utilities map of public sewers around the site (site boundary shown in red fill). The map does not include the extended treatment works in Wellington Docks.

United Utilities (UU) have confirmed that flooding due to sewer failure since the upgrade works has only occurred during very heavy intense storm conditions coinciding with a high tide. The nearest flood incident to BMD was 1km to the south, near to East Waterloo dock and the adjacent superstore. The large storage capacity of the MEPAS tunnel and its gated systems of outfalls make flooding rare and United Utilities have no recorded incidents or knowledge of any flooding in the vicinity of Bramley-Moore Dock.

A trunk water main is present beneath Regent Road to the north-west of the site and smaller distribution mains run north-south along Regent Road. A failure of these mains could lead to flooding within Regent Road, with the flow direction and extent mimicking the surface water flooding discussed in Section 3.3. Flooding would be directed north-east away from the site towards lower lying land around Blackstone Street and Boundary Street.

UU have indicated that there is no issue with flow capacity of the adjacent combined sewer pipes running underneath Regent Road, immediately east of the site. UU have approved connection to an adjacent UU chamber (UU REF.6501 in Regent Road) for the proposed development and has agreed to unrestricted flows. More information on the foul drainage can be found in the Drainage Strategy submitted as part of the Planning Application**.**

The site is considered to be at a ***low*** risk of flooding from sewers.

3.5 Flooding from Groundwater

Flooding from groundwater occurs when the water table in permeable rocks such as chalk and limestone rises to enter underground spaces such as basements and cellars or reaches a sufficient level to emanate from the ground surface itself. Groundwater flooding is not necessarily directly linked to a specific rainfall event and is generally of longer duration than other causes of flooding (possibly lasting for weeks or months).

3.5.1 Baseline

According to the LCC Preliminary Flood Risk Assessment (PFRA, 2011), there are no known records of groundwater flood risk in Liverpool. This could be attributed to the recording mechanism and the fact that it is unlikely such an event to have been correctly diagnosed.

A geo-environmental assessment of the application site has been undertaken by BuroHappold. Continuous monitoring of groundwater levels was undertaken in 2017-2018 over 6 or 12 months depending on location. This monitoring found near surface groundwater in Made Ground between approximately 3.2 and 6.4mAOD (generally above dock water level). Deeper groundwater recorded in Glacial Till, Tidal Flat Deposits and the Chester Formation showed tidal influence in response to levels in BMD and/or the River Mersey. The findings are summarised below:

- A near-surface groundwater body (perched groundwater) within Made Ground has been recorded on each of the four wharves (surrounding BMD). This is found at a level above that of the dock water (except at one borehole), and as such varies without tidal influence.
- Groundwater level within Made Ground has been found to be relatively consistent, except for a peak in early January 2018 (likely in response to rainfall) followed by a decline back to approximate average levels by mid-January.
- There are differences in the levels of groundwater in Made Ground on each of the four wharves, suggesting the water bodies are not in hydraulic continuity and that they relate to levels of impermeable materials on each of the wharves.
- Dock level shows a tidal influence, ranging over approximately 0.3m during a tidal cycle and with a 3 hour lag between high tide level of the River Mersey and maximum dock level. This indicates that the river wall is not

completely impermeable. The dock levels have been recorded to range between 3.8m AOD and 4.6m AOD, with a mean level of 4.3m AOD

3.5.2 Proposed development

Once sand-based fill material has been deposited in BMD to create the stadium building platform, the water level within the dock remains in hydraulic connectivity with the dock network until the construction of the northern isolation structure. Once the stadium is constructed, the groundwater beneath its footprint will be equalised with the groundwater in the wharves. However, the water level within the water channel (once excavated post construction) will remain in hydraulic connectivity with the dock network owing to the construction of pipes within the northern isolation structure. The level within the water channel will be subject to the typical water level variations present within the wider dock network. Extreme high water levels within the channel will only occur as a result of wider tidal flooding penetrating the dock network. In this case tidal flooding will present the primary flood risk rather than groundwater flooding.

There are no proposed basements; the risk of groundwater flooding to buildings is therefore considered ***low***.

3.6 Flooding from Artificial Sources

The Environment Agency map shows that there are no reservoirs located within the vicinity of the site and that the site does not lie within a breach flood flow path of a reservoir. According to the LCC PFRA, there are no LCC records of canal flooding and British Waterways' records show no canal breaches within Liverpool since a breach in 1940 caused by bombing.

With the information available, the site is considered at ***low*** risk of flooding from artificial sources.

4 Summary and conclusions

This FRA has been prepared in accordance with relevant policies of the statutory development plan (Liverpool UDP) and NPPF (paragraphs 155 to 165) to support a full planning application for a new football stadium with associated facilities and infrastructure (including at-grade car parking) at Bramley-Moore Dock in Liverpool. The FRA has assessed the risk of flooding to the site from fluvial, tidal, wave overtopping, surface water, sewers, groundwater and other artificial sources.

It is demonstrated that, while the application site is within Flood Zone 1 under current conditions, the risk of tidal flooding is raised to high when climate change is taken into account. Large portions of the site are anticipated to be flooded during the 2115 1 in 200 year flood event (DFE) based upon existing site levels.

In order to protect the proposed development from tidal flood risk, the following measures are proposed:

- The stadium ground floor level is raised 300mm above the DFE.
- The road along the north of the stadium is also raised above the DFE to allow dry access and egress.
- The OB kiosk, switchroom and transformers equipment will be raised 300mm above the DFL.
- Flood resilient measures will be incorporated within the ground level of the southeast and northeast stairwells and lift lobbies of the east stand of the stadium, at-grade car park and compounds located on the western wharf, e.g. raising of sensitive equipment at vehicle charging points.

A wave overtopping analysis has been undertaken for the current and future conditions. The Mersey River wall protects the site up to and including the estimated 1 in 2 year and 1 in 100 year event for pedestrian and vehicles respectively under present day conditions. The level of protection decreases to a 1 in 5 year event for vehicles under the climate change condition. Areas along the western boundary are not considered safe for pedestrians during any storm, under climate change conditions. Development within 15m of the River Mersey wall is predicted to be exposed to wave overtopping during the 1:200yr joint probability event with allowance for climate change. The mitigation measures proposed above for tidal flooding will also reduce the overtopping risk. Additional mitigation measures are proposed as follows:

- Drainage within the compounds located on the western quay designed to enable discharge of overtopped water.
- Ground levels are designed to allow discharge of overtopped water to the proposed western channel in the case of the piped drainage capacity being exceeded.

The risk of flooding from surface water, groundwater, sewers and artificial sources is considered low.

With the proposed mitigation measures in place, there is a residual risk of tidal and wave overtopping flooding in some parts of the application site. A flood warning and evacuation plan shall be prepared prior to occupation. The plan will include trigger points aligned with forecasted and live flood levels and /or rainfall predictions and the actions taken following the trigger points. A plan will be put in place to ensure the safe evacuation of staff and other non-match users if deemed required. Safe access and egress for vehicles and pedestrians is provided via the road along the north of the stadium, connecting to Regent Road. This will remain safe for use during the design flood event.

The drainage strategy ensures no flooding of the main stadium building for up to the 1 in 100 year event (with allowance for climate change). Some ponding limited to 10mm might occur within the SE and NE stairwells and lift lobbies of the proposed east stand; this will be managed through local gullies and sump pits in the lifts. Runoff is proposed to be discharged to the River Mersey unrestricted via the wider dock network. Downstream defenders are used at every outfall to control water quality.

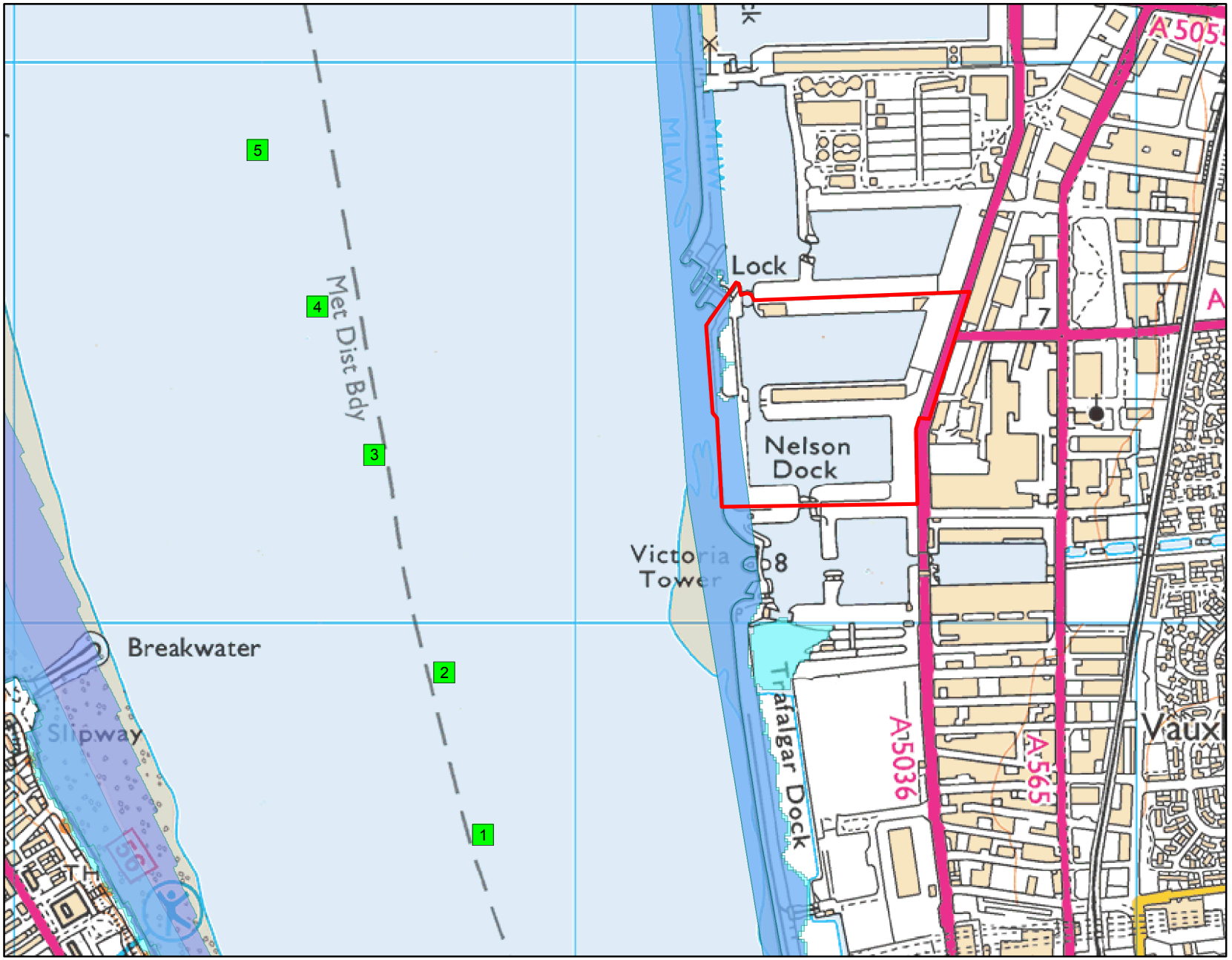
This FRA demonstrates that with the proposed mitigation measures in place, the development is safe up to and including the 1 in 200 flood event with allowance for climate change and does not increase flood risk elsewhere for the lifetime of the development. A residual risk of tidal flooding and wave overtopping to less vulnerable and water compatible uses is present and may be adequately managed through a flood warning and evacuation plan.

The proposed scheme is therefore compliant with the provisions of the statutory development plan (Liverpool UDP) and the National Planning Policy Framework (NPPF). There are no flood risk matters which would preclude positive determination of the planning application.

Appendix A Relevant pre-application correspondence

A.1 Information received from the Environment Agency

Detailed Flood Map centred on Bramley Moore Dock, Liverpool, L3 0AP. Created on 16/01/2019 [GMMC48051CC]



Environment Agency

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N

Legend

- Site Location
- Model Measurements
- Flood Zone 3
- Flood Zone 2

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

					Defended					Undefended	
Map Reference	Model Node Reference	Easting	Northing	Data	1 % AEP (1 in 100 year)	0.5 % AEP (1 in 200 year)	0.5% AEP (1 in 200 year) + Climate Change (2065)	0.5 % AEP (1 in 200 year) + Climate Change (2115)	0.1 % AEP (1 in 1000 year)	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	MEST_3500	332836	391621	Modelled Water Level (m aodN)	6.19	6.31	6.62	7.01	6.53	6.31	6.53
2	MEST_3250	332768	391912	Modelled Water Level (m aodN)	6.18	6.29	6.61	6.99	6.51	6.29	6.51
3	MEST_2750	332641	392301	Modelled Water Level (m aodN)	6.15	6.26	6.58	6.97	6.48	6.26	6.48
4	MEST_2500	332539	392563	Modelled Water Level (m aodN)	6.14	6.24	6.56	6.96	6.47	6.24	6.47
5	MEST_2250	332434	392843	Modelled Water Level (m aodN)	6.13	6.23	6.55	6.94	6.45	6.23	6.45

Model data taken from DRAFT Mersey Estuary 2016 Study

AEP - Annual Exceedence Probability

m aodN - metres above ordnance datum Newlyn

Notes:

*The impact of climate change was assessed by simulating a 200-year event including an increase in predicted sea-level rise up to the year 2065 and 2115. The new climate change guidance is available at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

Matthew Vaughan-Shaw

From: Cooke, Claire <Claire.Cooke@environment-agency.gov.uk> on behalf of GMMC Info Requests <Inforequests.gmmc@environment-agency.gov.uk>
Sent: 01 June 2017 14:16
To: Clare Jones
Cc: Sayce, Stephen
Subject: GMMC48051CC - Response from the Environment Agency
Attachments: GMMC48051CC_Map.pdf; GMMC48051CC_Table.pdf

** External E-Mail **

Dear Clare Jones

Thank you for your enquiry which was received on 19 May 2017.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Please find attached the data requested and see below for our officer's answers to your questions in red:

Extreme Water Level Predictions for the River Mersey. See Product 3 Map and Table.

Status of extreme water level predictions. Latest water level predictions have been provided but should be treated as draft.

Flood Defence information. There are no flood defences in the vicinity of the site.

Monitoring data for the River Mersey. Not for PSO Hydrometry and Telemetry should be able to provide this.

Historical flood information. We have no records of flooding affecting the site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Liverpool Council who may hold additional information (the former especially in relation to sewer flooding).

Current flood modelling of the docks. No Overtopping or Breach Analysis has been delivered for the Mersey Estuary 2016 model.

Please refer to the Open Government Licence which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Kind regards,

Claire Cooke
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
External: 0208 474 9502
Email: Inforequests.gmmc@environment-agency.gov.uk

From: Clare Jones [mailto:Clare.Jones@BuroHappold.com]
Sent: 19 May 2017 18:20
To: Sayce, Stephen <stephen.sayce@environment-agency.gov.uk>
Cc: Matthew Vaughan-Shaw <Matthew.Vaughan-Shaw@BuroHappold.com>; Alan Travers <Alan.Travers@BuroHappold.com>; Christopher.Argent@cbre.com; J.Williams@Gardiner.com; Lloyd Baker <Lloyd.Baker@BuroHappold.com>
Subject: FW: Project Blue: Privileged and Confidential EA Pre-application Enquiry

Dear Stephen,

We have submitted a pre-application enquiry today to the EA for Project Blue at Bramley Moore Docks, in Liverpool (see attached). We have been passed on your contact details from Peter Jones at Liverpool City Council and I understand you have been in contact with him regarding the project. We hope to be able to discuss the project with you once the pre-application has been reviewed.

I have cc'ed in Christopher Argent (CBRE) as although we are listed as the contacts for this pre-application enquiry, any wider based queries on the project may be directed through CBRE.

Kind Regards,
Clare Jones

Clare Jones CEng MICE
Senior Engineer
BuroHappold Engineering | Water
T: +44 (0)1225 320600
www.burohappold.com | @burohappold

From: Clare Jones
Sent: 19 May 2017 18:15
To: 'SPPlanning.RFH@environment-agency.gov.uk' <SPPlanning.RFH@environment-agency.gov.uk>
Cc: Matthew Vaughan-Shaw <Matthew.Vaughan-Shaw@BuroHappold.com>; Alan Travers <Alan.Travers@BuroHappold.com>; 'Christopher.Argent@cbre.com' <Christopher.Argent@cbre.com>; 'J.Williams@Gardiner.com' <J.Williams@Gardiner.com>; Lloyd Baker <Lloyd.Baker@BuroHappold.com>
Subject: Project Blue: Privileged and Confidential EA Pre-application Enquiry

Dear Sir/Madam,

Further to my telephone conversation with Laila Berry earlier, please find enclosed the pre-application enquiry for Project Blue, located in Liverpool Docks. Accompanying this is also a supplementary note with our information request and items we would welcome the Environment Agency's stance on. I have cc'ed in Christopher Argent (CBRE) as although we are listed as the contacts for this pre-application enquiry, any wider based queries on the project may be directed through CBRE.

Kind Regards,
Clare Jones

Clare Jones CEng MICE
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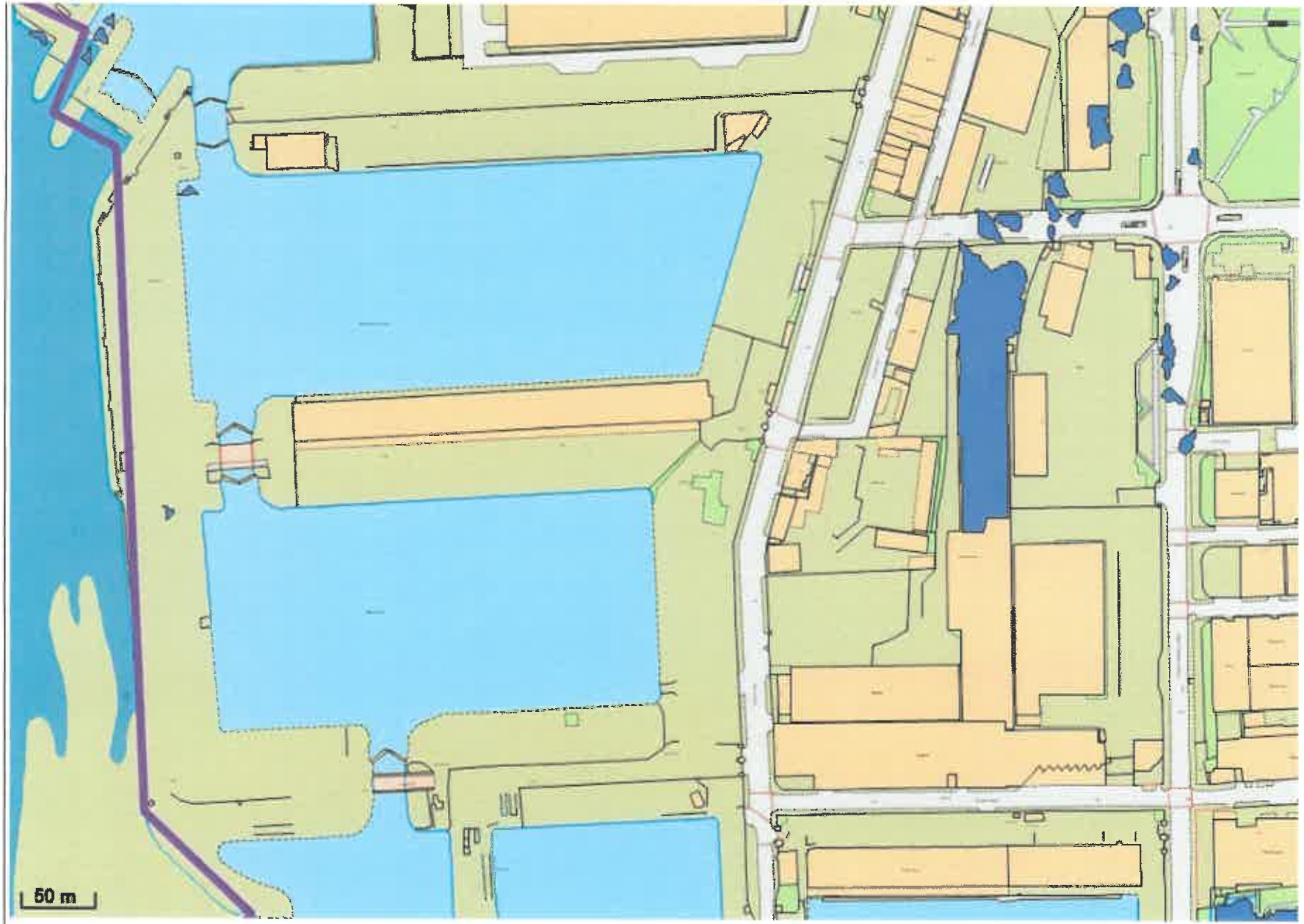
www.burohappold.com | @burohappold

A.2 Information received from the LLFA



Title: BRAMLEY MOOR DOCK

OS MasterMap Colour Raster

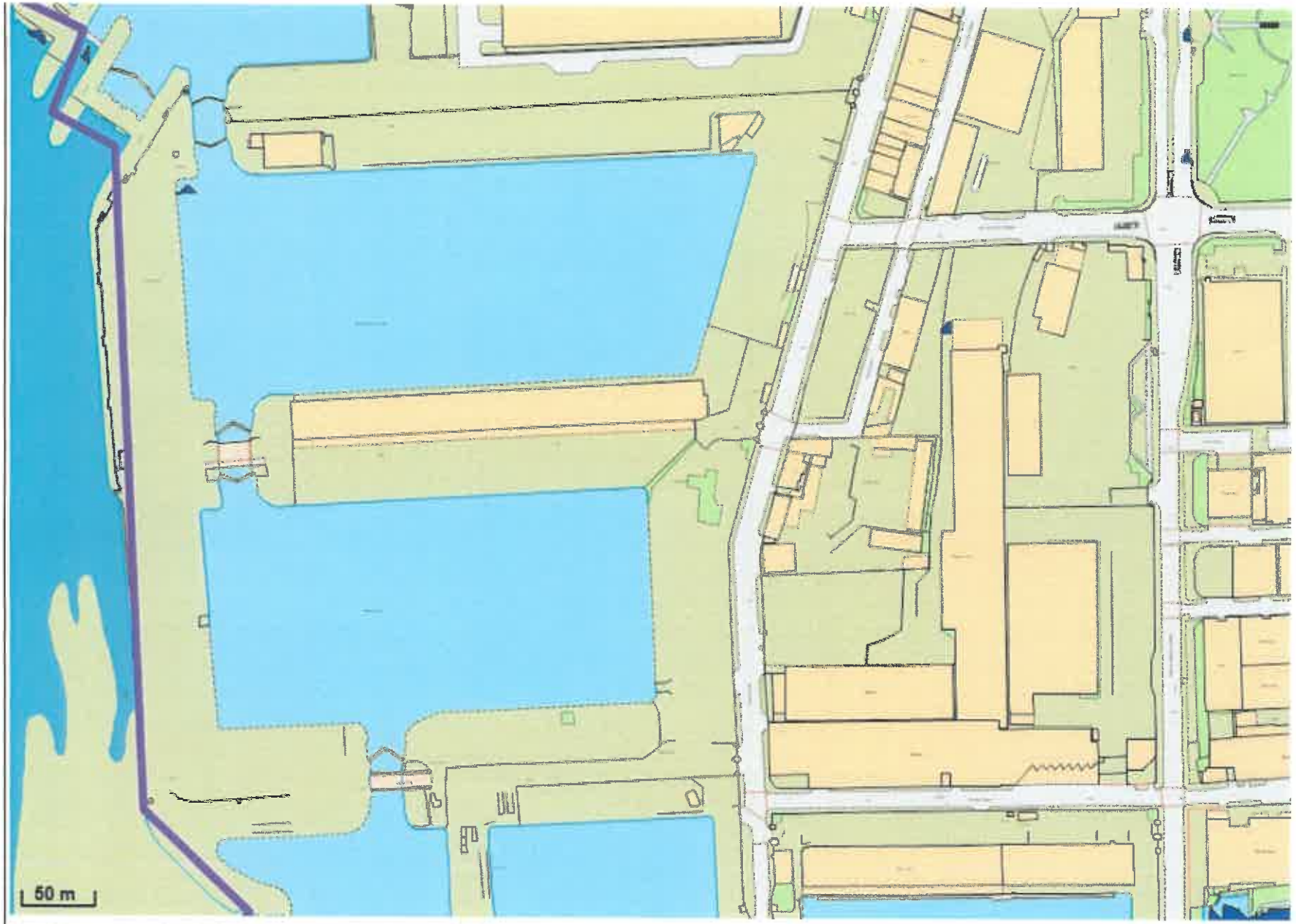
LCC Boundary

100 Year Merged 2m
2-100mm Region

Printed By:
Highways Highways

Printed On:
20-02-2019

Liverpool
City Council



Title: BRAMLEY MOOR DOCK

OS MasterMap Colour Raster

LCC Boundary

30 Year Merged 2m
2-100mm Region

Printed By:
Highways Highways

Printed On:
20-02-2019

Liverpool
City Council

LCC GREENFIELD / BROWNFIELD SITES SURFACE WATER MANAGEMENT GUIDANCE FOR PLANNING APPLICATIONS

Version 3 – May 2018

If the site has previously been developed it should be demonstrated that the drainage system is still operational for it to be classed as brownfield. Information should be obtained on the system, e.g. pipe diameters, levels, gradients, lengths, hydraulic controls, etc. These details should be used, along with the contributing area characteristics of the site, to set up a drainage model (or to inform another assessment method) in order to evaluate the peak flow rates at the outfalls from the existing site for the design return period events. The maximum allowed flow from the site should then be derived using the 1:2yr critical rainfall event with a 30% reduction applied to offer improvement.

The limiting discharge figure for the proposed development should be used in the design of the drainage system for the minimum requirement that flows for up to the 1:30yr critical rainfall event are retained within the system and that for the 1:100yr+30% climate change allowance, critical rainfall event there will be no flooding to any buildings and any excess volumes of water will be retained on site.

Hydraulic calculations for drainage designs submitted as part of a planning application should be carried out using MicroDrainage or an industry approved alternative ie certified by the Water Research Council.

Notwithstanding the above, the existing site drainage constraints will also be taken into account when agreeing any discharge limits and the proposed flow should not exceed existing pipe capacity. For example if the existing site outfall was a 150mm dia pipe, irrespective of the area being drained, it would have a maximum flow capacity which may be lower than any proposed flows calculated using the above criteria, assuming a free discharge. Therefore discharge to the existing drainage system from the development would be effectively increased from the existing situation which is contrary to Environment Agency and National Planning Policy Framework guidance for flood risk and surface water management.

Where records of the previously developed system are not available and system characteristics cannot otherwise be determined, or if the drainage system is broken or blocked (or no longer operational), then the run-off characteristics should be defined as greenfield.

If a site is classed as greenfield the flow rates from the development will be limited to the equivalent greenfield run off rates. For example the flow rate from the development for the 1:30yr critical rainfall event should not exceed the greenfield run off rate for the site for the 1:30 year rainfall event likewise for the 1:100 year scenario. A minimum flow of 5 l/s can be used when the greenfield run off rate falls below 5 l/s.

It should be noted that this discharge figure will satisfy planning requirements but the applicant should consult United Utilities to determine if they have any discharge restrictions, which could be more restrictive.

For greenfield developments if the attenuation system is to be adopted by United Utilities then the minimum flow can be increased to 6.5 l/s in line with United Utilities requirements.

For developments containing prospectively adoptable surface water sewers and guidance related to SUDS, documents on United Utilities website should be referred to.

For all development s over 1ha a FRA (Flood Risk Assessment) will be required which should be based on the requirements as detailed in Environment Agency (Greater Manchester, Merseyside & Cheshire) Local Planning Standing Advice and NPPF guidance. The detail and technical complexity of a FRA will reflect the scale, nature and location of the development. Where available, reference should be made to the Strategic Flood Risk Assessment (SFRA) for locally specific guidance and information.

The following list sets out key information that should be submitted within a FRA for developments

- A location plan that includes geographical features, street names and identifies the catchment, watercourses or other bodies of water in the vicinity.

- A plan of the site showing existing site; development proposals; and identification of any structures (e.g. embankments), which may influence local flood flow overland or in any watercourses (e.g. culverts) present on the site.

- Site levels of both existing and proposed. Reference to Ordnance Datum, may be required where details of context of the site to its surroundings is needed.

- Details of the existing surface water drainage arrangements on site (if any) and the receptor e.g. soakaway, sewer, canal, watercourse etc.

- Proposals for surface water management that aims to not increase, and where practicable reduce the rate of runoff from the site as a result of the development

- Information about the surface water disposal measures already in place and estimates of the rates of run-off generated by the surfaces drained.

- An assessment of the volume of surface water run-off likely to be generated from the proposed development and confirmation of how any excess volumes would be retained within the development.

- Information regarding how the proposed drainage design will perform under the increased frequency and intensity of rainfall that is predicted as a result of climate change (30% for residential development & 20% for non- residential).

- Information about other potential sources of flooding, if any, that may affect the site e.g. streams, surface water run-off, sewers, groundwater, reservoirs, canals and other artificial sources or any combination of these; including details on how these sources of flooding will be managed safely within the development proposal.

It should be noted that the above list is not exhaustive but provides a framework for the FRA to be prepared.

For developments less than 1 ha a FRA will not be required but a drainage design statement should be provided proportional to the scale of the development and follow the same design principles with regards to the calculating the maximum design flow rates for the site.

In line with NPPF (National Planning Policy Framework) the development of a site should look towards the use of SUDS techniques as a method of reducing the run off from the site, as a result of the development. Government policy strongly encourages a hierarchical approach to the use of sustainable drainage systems in new developments and infiltration methods for private drainage should be used where possible.

For residential developments greater than 0.5 ha and where the floor space of any building is greater than 1000m² ground Investigations should be carried out to BRE 365 to determine if infiltration drainage methods are practicable and suitable for the sites. A soils report including ground percolation test results and recommendations will need to be submitted within the drainage design statement or FRA, for approval, although any detailed soakaway design information is not required at this stage. If this proves that infiltration drainage is not a viable option, then a positive piped system of surface water run off disposal will need to be provided.

Any soakaway design and the sub ground strata of the sloping site areas shall be considered so as not to cause flooding to any adjoining third party land.

Details will be required for implementation, maintenance and management of the any attenuation system or other sustainable drainage where it is not to be adopted by United Utilities. The details should include:

(i) A timetable for its implementation.
(ii) A management and maintenance plan for the lifetime of the development.
(iii) Contact details must be supplied for person / company responsible for this maintenance.

It should be noted that this information will not be required prior to any approvals and will be covered under a condition for any planning approvals.

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Planning Applications

2.13. Planning applications may be made either as an Outline application with one or more matters reserved for later determination, or as a Full application.

2.14. The level of information which would need to be submitted for each type of application or stage within the planning process will vary depending on the size of the development, flood risk, constraints, proposed sustainable drainage system and so on as shown in the table below:

Pre-app	Outline	Full	Reserved	Discharge	Document submitted
✓	✓	✓			Flood Risk Assessment/Statement (checklist)
✓	✓	✓			Drainage Strategy/Statement & sketch layout plan (checklist)
	✓				Preliminary layout drawings
	✓				Preliminary "Outline" hydraulic calculations
	✓				Preliminary landscape proposals
	✓				Ground investigation report (for infiltration)
	✓	✓			Evidence of third party agreement for discharge to their system (in principle/ consent to discharge)
		✓		✓	Maintenance program and on-going maintenance responsibilities
		✓	✓		Detailed development layout
		✓	✓	✓	Detailed flood & drainage design drawings
		✓	✓	✓	Full Structural, hydraulic & ground investigations
		✓	✓	✓	Geotechnical factual and interpretive reports, including infiltration results
		✓	✓	✓	Detailed landscaping details
		✓	✓	✓	Discharge agreements (temporary and permanent)
		✓	✓	✓	Development Management & Construction Phasing Plan

Additional information may be required under specific site conditions or development proposals.

2.15. Whether the application is an outline or full application, the surface water drainage for the application is determined at the time when the application itself is determined.

2.16. Following an outline application, reserve matters must be consistent with the drainage strategy which was approved.

2.17. For a full application it would usually be necessary for a fully detailed drainage design or strategy to be submitted for consideration by the LPA and to be subject to comment by the statutory consultees or others that the LPA may wish to consult.

2.18. The drainage strategy may include a Flood Risk Assessment, but in some circumstances a fully detailed design does not form part of a flood risk assessment.

Statutory Consultations

2.19. The Lead local Flood Authority is the statutory consultee for Major development with surface water drainage. However, local arrangements may exist between the LPA and the Lead Local Flood Authority (LLFA) with regard to providing advice/comments on Minor development.

2.20. The Environment Agency is the statutory consultee, as stated in the:

Development Management Procedure Order 2015 for:
Development involving the carrying out of works or operations in the bed of, or within 20 metres of the top of a bank of, a main river which has been notified to the local planning authority by the Environment Agency as a main river for the purposes of this provision

Development, other than minor development, which is to be carried out on land:
(i) in an area within Flood Zone 2 or Flood Zone 3; or
(ii) in an area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency

Non-Statutory Consultations

2.21. It would be normal if discharging to a drainage system maintained/operated by other authorities (IDBs, highway authority, sewerage undertaker, or Canals and River Trust) that evidence of consultation and the acceptability of any discharge to their system is presented for consideration by the LLFA and LPA.

A.3 Meeting minutes - Pre-application consultations

BUROHAPPOLD ENGINEERING

Meeting Minutes

Subject	Project Blue: Privileged and Confidential EA Flood Risk	Job no	0040026
Place	EA Offices, Richard Fairclough House, Warrington, WA4 1HT	Date	13 June 2017 @ Noon
Present	Stephen Sayce - Environment Agency (EA) Graham Bates - EA Peter Jones - Liverpool City Council (LCC) Alan Travers - BuroHappold Engineering (BHE) Clare Jones - BHE Patrick Little - CBRE	Apologies	Graham Todd - EA
Distribution	Present + Apologies		

Objective of meeting: To discuss and agree the flood risk principles for the proposed Project blue development

Item	Action
1.0 Introduction 1.1 Introductions • Apologies were given for Graham Todd (from the EA Flood Risk Team) as he had been called away shortly before the meeting. Graham Bates from the same team stepped in to attend. 1.2 Project Blue Introduction • BHE introduced the Project Blue project and explained that the project was confidential. The EA confirmed that as long as the information submitted to them was labelled 'Privileged and confidential' then this would be treated as such. Once a planning application is submitted, then this would be within the public domain. • BHE confirmed that the purpose of the meeting was to discuss the flood risk principles for the Bramley Moore Dock site. The EA confirmed that as the Goodison Park site was within Flood Zone 1, the EA would refer to Liverpool City Council as Lead Local Flood Authority (LLFA).	
2.0 Review of Information available from Environment Agency	

2.1	Extreme Water level predictions for the River Mersey and methodology used to determine these	
	• BHE tabled the draft Mersey Estuary 2016 flood levels received from the EA as part of the Product 3 information. BHE noted that the 1 in 200 year still water flood level has increased from 6.11mAOD (Liverpool Waters' 2008 level) to 6.38m AOD (2016 draft flood levels).	
	• BHE noted that the modelled 2115 1 in 200 year flood level was 7.05m AOD, approximately 200mm lower than they expected. BHE had anticipated the level to be 7.25m AOD based on calculating the 2016 1 in 200 year flood level with climate change allowance in accordance with current national published guidance. The EA agreed to come back with their clarification on how the modelling was undertaken and the approach that has been taken for climate change.	EA
2.2	Status of Extreme Level predictions	
	• The EA has advised that the 2016 Mersey Study is in draft and a date for release is not known. The EA advised that there is a risk that these levels could go up. BHE advised that a planning application for the site is programmed towards the end of the year. The EA would seek clarification on when the draft flood levels were due to be issued.	EA
	• The EA advised that a review at the time of the planning application would be required to determine what flood levels could be used. If the 2016 draft flood levels are not finalised, this may require reverting to the previous 2008 levels.	
	• BHE advised that the Liverpool Waters' FRA was based on 2008 level predictions and since then, the EA issued the 2011 Coastal Flood boundary conditions for UK mainland and islands report. In that report, the 1 in 200 year level at Gladstone Dock was calculated as 6.60m AOD which was higher than the current predictions and would have a significant impact on the development proposals. The EA confirmed that they would revert to the Liverpool Waters FRA flood levels and not the 2011 levels.	
	• The EA suggested in the interim while the design was being developed, a freeboard of 300mm could be used for determining the finished floor levels, rather than the 600mm currently allowed. This would allow for the flood levels provisionally adopted to increase in in the order of 200-300mm. BHE to review. (Refer to section 4.3 for more details).	BHE
2.3	Current flood modelling of the docks	
	• BHE noted that there are raised walls over most of the length of the river fronting the site and the various gates providing navigation access into the docks have since been infilled. Most of these are at a level lower than the raised river walls. The EA confirmed that no breach modelling has been undertaken as the walls along the river are not EA formal flood defences.	
	• The EA are going to seek clarification if overtopping of still water levels into the docks was considered in the 2016 modelling.	EA
2.4	Flood Defence Information	
	• The EA confirmed that there are no formal flood defences on the site.	

2.5 Monitoring Data for the River Mersey • BHE explained that groundwater levels will be monitored as part of the Ground Investigation. BHE wish to understand if there is an interaction with the river levels and would like to compare groundwater and Bramley Moore dock basin water levels against river monitoring data. The EA will send through contact details for the Hydrometry and Telemetry team and have recommended BHE to speak to Lee Beverage from the EA's Ground Contamination team.	EA
2.6 Historical flood information • The EA has previously confirmed that they have no records of flooding on site. The EA has recommended contacting United Utilities and Liverpool City Council.	Project Blue Design Team
3.0 Flood Levels for the site 3.1 Nearest Flood Level information for the site • The EA confirmed that as the site lies between two 2016 modelling points on the river, the draft 2016 estimated flood levels can be interpolated to define the flood levels at the site. 3.2 Approach to assessing flood levels for the site • Modelled Levels o Refer to section 2.1. o BHE advised that they have received guidance from G&T, the Project Managers on Project Blue, that the design life for the development is 60 years. The EA raised their concerns that the stadium was likely to be there for 100 years and if it was only designed for 60 years, it would not take account of predicted climate change associated with the additional 40 years. The EA would expect to see a design life of 100 years but advised that they would defer to LCC. LCC were minded to agree but proposed to review and to provide a formal response. BHE requested that no formal response was provided before BHE had taken account of the outcome of this meeting. • Consideration of wave overtopping and breach o The EA confirmed that they did not require a breach analysis to be undertaken as there was not a continuous flood defence on the site and tidal water would make its way into the dock. o The EA would like to see consideration of wave overtopping in the Flood Risk Assessment (FRA). The EA confirmed that they had no wave data for the area and advised that for the Liverpool Waters FRA, it had been agreed to add a 10% factor for wave action based on previous guidance in PPS25. The EA are looking for an acknowledgement of wave overtopping within the FRA but will leave BHE to determine how this is considered. The EA confirmed that the raised walls along the river are not formal flood defences and are not continuous. The walls are therefore not effective flood mitigation for the	LCC

site and so the dock water level should be assumed to be the same as the river water levels.	
4.0 Minimum Development/ Threshold Levels 4.1 Flood Levels for the Site Refer to sections 2.1 and 3.2 for more details. 4.2 Allowance for Climate Change • Refer to section 2.1. The EA to confirm their approach taken to climate change allowance for the modelling. 4.3 Approach to Freeboard • The EA advised that their recommendation for freeboard is 300mm for commercial uses and 600mm for residential buildings. As the stadium would be considered commercial, the EA advised the freeboard would need to be a minimum of 300mm (including basement car parks) but the Club may wish to increase this if they wish to reduce their risk further. Note that this is a reduction on the freeboard from the Liverpool Waters' FRA. 4.4 Minimum Development/Threshold Levels for ground floor uses • The EA agreed that the minimum development/threshold levels were built up on the basis of the 1 in 200 year still water flood level with allowance for climate change and freeboard. • The minimum development/ threshold levels for the site were unable to be confirmed in the meeting and all agreed that there were different combinations to build up the levels. The EA has an action to confirm their approach to climate change allowance. 4.5 Minimum Threshold Levels for basement uses • The EA confirmed that the minimum threshold levels for basement uses would be based on the 1 in 200 year still water flood level with allowance for climate change and 300mm freeboard.	EA EA
5.0 Safe Access and Egress Provision 5.1 Location and Level • The EA agreed to the approach of providing a single raised safe access/ egress route from Regent Road at the level of Regent Road (7.1mAOD) with everyday access at grade (circa 6.6m AOD). • The EA advised that a flood and evacuation management plan would need to be in place to manage the residual risk. This would need to be approved by the Emergency Planners. • The EA advised that the Club would need to sign up for the Flood Warning Service. This would provide the Club's Facilities Management Team with a predicted flood warnings/level and timeframe. The EA advised that the typical lead in time is between 6-9 hours.	
6.0 Review of Current Proposals 6.1 Building Proposals • LCC were keen to avoid raising the site above what was necessary for flood risk to avoid losing the heritage context. BHE advised that the EA would	

not accept the stadium at the existing dock level and therefore there would need to be raising of the development platform. BHE explained that the philosophy was to preserve the heritage in-situ by raising levels and designing the piled foundations away from the dock walls. Whilst the development platform for the stadium is being raised, BHE advised that the surrounding areas such as the fan zone and car parking are proposed to be retained at existing level to retain heritage features as far as possible. In addition, options are being explored to create a channel on the west of the site to provide visual connectivity between Sandon Half Tide Dock and Nelson Dock. BHE advised that there was an initial meeting planned with Historic England on Saturday 17th June. It was agreed to review the levels once the stance on climate change and design life were provided. • The EA agreed to the principle of having at grade car parking at the existing dock level to the west of the site, if that was the option being promoted, although other options were being considered. Wave overtopping should be considered within the design. • For surface water drainage, the EA advised that consideration would need to be given to the tide locking scenario when discharging to the river. The Design Team will need to consult with the LLFA. 6.2 Infilling of Dock Basin See section 7.1	All
7.0 Future Consents Required 7.1 Environmental Permits • The EA confirmed that there were no consents required associated with flood defences or any access requirements to the river wall. The EA advised that this stretch of the River Mersey is defined as an Ordinary Watercourse and therefore the consenting authority is Liverpool City Council. The contact to discuss this with is Laura Gilmore and Peter Jones will forward her contact details. • The EA advised that no discharge consents were required for discharging clean surface water into the River Mersey from the developments' surface water drainage. • The EA advised that they were not anticipating the requirement for abstraction licences. The EA anticipate a discharge consent would be required for the water that is being displaced during the backfilling of the dock basin. Following this meeting, there was a second meeting to discuss the EIA scoping report response relating to waste management. The following was discussed: • BHE advised that the intention was to use sea dredged aggregates from a licenced site, likely in Morecambe Bay to infill the dock. The filling methodology is likely to be similar to that used to fill the Wellington Dock. Following the meeting, the EA are to confirm whether virgin sea dredged aggregates could be classified as waste for the filling operation without the use of the CLAIRE code of practice or a recovery permit.	EA

• The EA advised that if the dredged material was potentially going to be classified as waste, there were two routes to allow its reuse without it becoming classified as a waste: 1. Waste Recovery Permit. The EA offers to indicate at no charge whether the filling activity would pass the economic test for Waste Recovery. 2. CL:aire Code of Practice to manage the material outside the waste regulations. The EA advised that the amount of material to be infilled would exceed the amount allowed under the U1 exemption licence. • With regard to silt material potentially being dredged from within the dock basin, the EA indicated two possible options. 1. Traditional approach of disposing offsite (the EA advised that there was lots of capacity within the local area for material to be disposed) 2. Cement stabilising the material and re-using on site under the CL:aire Code of Practice. • BHE advised that option 2 was unlikely to be practicable, given the potential volume but that the Design team was looking at the option of retaining the silt in-situ. BHE advised that they had researched a case study where this has been done in Liverpool Docks. The EA requested that details be sent through and to start the consultations early with Lee Beverage. (Note: Stephen Sayce will be acting as our main point of contact in the EA and we should first contact him). • The EA highlighted sites that may require the excavated dock silt material: Bromborough Docks and Festival Gardens. Both of these sites have no guarantees of going ahead at this stage. • The EA advised that a Local Authority exemption would be required for crushing and demolition. For waste treatment on site, the EA advised that a mobile permit would be required.	BHE
8.0 Any Other Business • The EA considered that works within the docks would fall within the MMO and Local Planning Authority jurisdictions for consents. CBRE confirmed that the MMO are being consulted on the scoping of the EIA. • The EA advised that they would consider a Water Framework Directive Assessment was needed to be undertaken for the project. The EA would discuss this during the Ecology meeting together with surveys required. • The EA advised to LCC that they were expecting to have a scoping report response to the LCC by next week (w/c 19th June 2017). • Post Meeting Note: The EA has recommended discussing the flood risk Sequential Test with Liverpool City Council to ensure that the application is robust.	EA/WYG EA Project Blue Design Team

The minutes detailed herein reflect the author's recollection of the discussions held during the meeting detailed above. If you feel that these minutes are inaccurate; proposed additions, corrections and/or comments must be submitted to the author in writing within five working days of the date of these minutes. If no written responses are received within this period, these minutes will be deemed the official record of the meeting.

Minutes taken by: Clare Jones

BUROHAPPOLD ENGINEERING

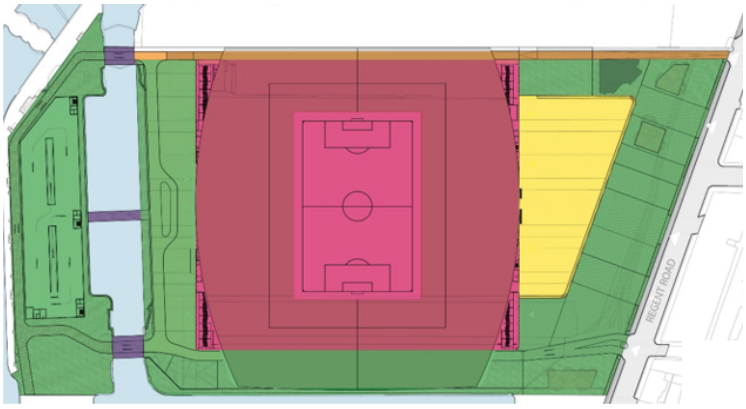
Minutes

Subject	Project Blue: Privileged and Confidential Flood Risk and Surface Water Drainage Meeting with EA and LCC	Job no	0040026
Place	Liver Building, Liverpool	Date	19 February 2019
Present	Stephen Sayce – Environment Agency (EA) Graham Bate – EA Peter Jones – Liverpool City Council (LCC) Dave Jackson - LCC Alix Craig – EFC Peter Wardle – Gardiner & Theobald (G&T) Helen Clarkson – CBRE Georgina Baines – Planit IE Sean Swarbrick - Planit IE Jon-Scott Kohli – Pattern Design Matthew Vaughan-Shaw- BuroHappold Engineering (BHE) Nick Hall – BHE Rob Frost – BHE Clare Jones – BHE Dr Sam Fox – United Utilities	Apologies	
Distribution	As above and: Graham Drennan – Gardiner & Theobald (G&T) Mario Samara – Meis Architects Alan Travers - BHE		

Objective of meeting: To provide an update to the EA and LCC on Project Blue and to agree in principle the flood risk management strategy for the development including minimum development levels

Item	Action
1.0 Introductions	
1.1 Introductions	
1.2 Project Blue Update	

Outline of Stage 2 scheme design provided which includes a 52,000 seat stadium orientated north – south in the centre of the site. A canal channel to the west with a car park structure located on the west wharf beyond. To the east of the stadium is an open area of fan zone and the existing hydraulic engine house.



It was explained that future site levels are determined by three factors: 1. Historic England requirements which are to keep the site as close to its historic levels as possible; 2. Constructability requirements which means that the new stadium structure has to pass above the existing historic dock wall and below finished floor level within the stadium: and 3. Building and access levels must be protective from future flooding.

Based on these requirements a level of 7.3mAOD within the stadium footprint has been proposed with lower levels in the surrounding area. This was the basis for the following discussion.

In addition as part of Stage 2 design BuroHappold have developed a preferred surface water drainage strategy and a discussion on the suitability of this strategy also took place and is detailed here.

2.0 Review of information available from the Environment Agency

2.1 Review of the information received from the EA

- BHE tabled the latest flood levels provided from the EA in January 2019 which source the data from the 'DRAFT Mersey Estuary 2016 Study'.
- Previously, the flood level information received from DRAFT Mersey Estuary 2016 Study had been considered to be draft. The EA confirmed that the latest flood levels were now considered finalised.

2.2 Extreme water level predictions for River Mersey and methodology used

- The EA advised that the Mersey Estuary hydraulic model incorporated climate change allowance and a degree of wave action in the order of a 1 in 1 year event. The EA agreed to send to BHE the hydraulic model and/or the report in order for BHE to understand the design parameters used.

EA

2.3 Status of the latest model information received January 2019

- The EA confirmed that the flood levels provided in January 2019 were now finalised.

- The EA advised they were in the process of updating their flood mapping and were expected updated maps by summer 2019. These would be indicative as the EA do not hold detailed topographic survey information.

3.0 Flood Levels for the site

3.1 Flood levels information to be used

- The EA confirmed that the flood levels provided in January 2019 should be used for the Flood Risk Assessment.

3.2 Approach to assessing flood levels for the site

- Modelled Levels
    - BHE tabled the 2019 flood levels from Node 3 (MEST_2750) within the River Mersey.
    - BHE explained that there is an upstand wall along the river wall. Whilst it is not considered continuous and not a formal flood defence wall, it is likely to provide some benefits to the site. BHE has taken the approach however, that the flood level within the River Mersey is assumed to be the same level at Bramley Moore Dock. The EA agreed with this approach.
- Allowance for Climate Change
    - BHE explained that the EA 2115 1in 200 (0.5%AEP) modelled flood level was approximately 200mm lower than if the 2016 1 in 200 (0.5%AEP) modelled flood level had climate change allowance added in accordance with NPPF guidance. In 2017, the EA had previously advised to use the latter approach to define the 2115 flood levels.
    - The EA confirmed in this meeting that the climate change allowance had already been included within the hydraulic model and so the 2115 1 in 200 (0.5% AEP) flood model level can be used within the FRA. This is 6.97m AOD at the site (taken from Node 3).
    - The EA advised that the UKCP18 guidance may change the climate change allowances required for developments but as yet did not know what these changes would be. The EA confirmed they would take a flexible approach to this as the FRA was being prepared now for a planning submission.
- Consideration of wave overtopping and breach
    - The EA reconfirmed that breach modelling was not required as the river wall is not a formal flood defence
    - BHE advised that wave overtopping will be looked at within the FRA. Preliminary analysis has identified that the main mechanism is from still water flooding rather than overtopping. Due to wave heights being relatively low, significant overtopping is only anticipated to occur during periods of extreme high water within the river. It is proposed that the site would already be evacuated under such conditions and therefore the additional risk posed by

BHE

wave overtopping is minimal. BHE have currently used a wave height of 0.6m based upon Maritime and Coastguard Agency documentation. BHE will undertake further sensitivity analysis during preparation of the FRA with the aim of obtaining additional wave data.	
o LCC recommended reading the High Link Road FRA as wave overtopping was undertaken for the development and may have sources of wave data within it.	BHE
o The EA to review the model to see if there is wave data which can be provided.	EA
4.0 Minimum Development/ Threshold Levels	
4.1 Flood Levels for the Site	
• BHE provided the tabled the 2019 flood levels from Node 3 (MEST_2750) within the River Mersey.	
4.2 Design life for the Development	
o The EA noted that commercial buildings would have a design of life of 60-75 years whilst residential would have 100 years design life in relation to flood risk.	
o The EA confirmed that the design life may be considered to start from when the planning application is submitted.	
o LCC had no comments regarding design life. However, they recommended front loading the planning application to avoid conditions to make the planning process easier.	
4.3 Allowance for Climate Change	
o As discussed in section 3.2.	
4.4 Approach to Freeboard	
o The EA confirmed that 300mm of freeboard was appropriate and acceptable for the development. A higher freeboard of 600mm would be typical for residential uses.	
4.5 Minimum development/ Threshold Levels	
o The EA confirmed that a development level for the stadium of 7.3m AOD was acceptable to the EA. This would be based on the 2115 1 in 200 (0.5% AEP) flood level with 300mm freeboard. The EA accepted that the stadium did not require 100 years of climate change allowance.	
o BHE tabled the Development Levels figure in Appendix A showing the proposals based on a minimum development of 7.3m AOD for the stadium.	
o BHE explained that the existing Hydraulic Engine House is proposed to be refurbished. The proposals have not yet been fully developed but they could include a café. The existing finished floor is approximately 6.6m AOD. Flood resilience measures will be incorporated within the design and where possible, kitchen areas raised above the 7.3m AOD level. The EA agreed with this approach.	

- BHE explained that the proposed car park located to west of the stadium would be at grade at the existing dock level (approximately 6.6mAOD). There will be toilets and lifts within the ground floor cores. Flood resilient measures will be considered during the design. The EA agreed with this approach.
- GB presented the Fan Zone approach where most heritage aspects are concentrated. BHE noted the proposal to maintain existing levels within the Fan Zone, with the infilled part of the dock raised to meet the existing coping level. Existing levels will also be maintained within the area between the Fan Zone and Nelson Dock to the south, which will create a flood route between Nelson Dock and the Fan Zone during the design flood event. The EA accepted the principle that the Fan Zone may flood during the design flood event. The EA queried whether any structures would be installed within the Fan Zone. BHE confirmed that any structures would be of a temporary nature, e.g. temporary performance stages, or shipping container style kiosks.
- Planit described the proposal to create a shallow water feature within the northern part of the Fan Zone by locally lowering a section below the dock wall coping. It would be possible to drain the water from this feature on match days.

5.0 Safe Access and Egress Provision

5.1 BHE explained that in the event of a flood warning on or prior to a match day, the match would be cancelled. Therefore evacuation of tens of thousands of people is not required as part of the flood management strategy. The provision of a safe access and egress route is therefore being considered for the evacuation of staff on the site.

5.2 BHE tabled the proposed safe access and egress route along the northern boundary of the site. BHE explained that this access route is proposed to be provided at a minimum of 7.1m AOD to match the level on Regent Road. A route through the stadium at 7.3m AOD will be provided as shown in Appendix B. The EA agreed to this approach and did not identify a requirement for vehicular and pedestrian route at 7.1m AOD around the stadium.

5.3 A Flood Warning and Evacuation Plan will be required to manage closure and evacuation of lower areas of the site including the at grade car park and riverside walkway. This approach was acceptable to the EA.

6.0 Surface Water Drainage Strategy

6.1 Discharge Rates and Route

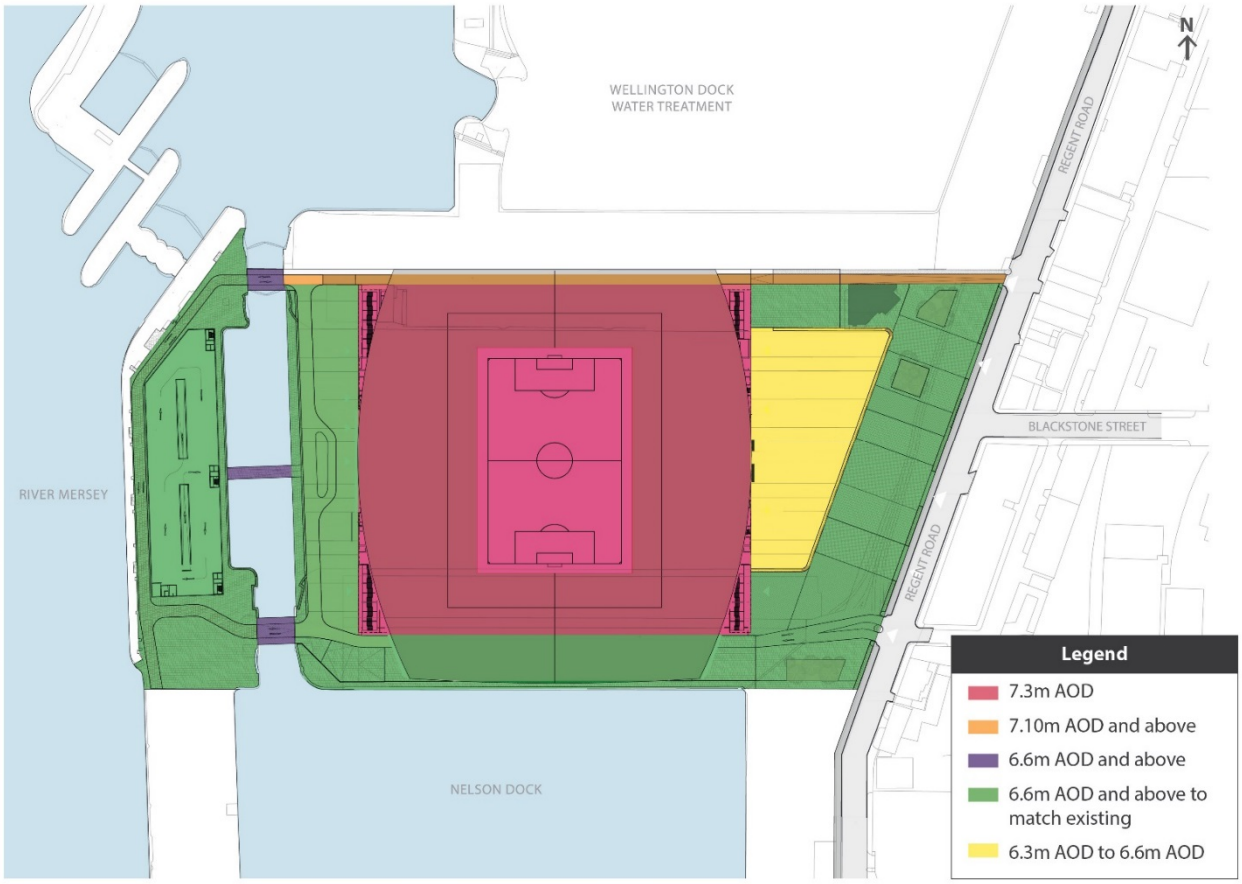
- LCC advised that there is the Liverpool Integrated Model for surface water flooding for the 1 in 30 year and 1 in 100 year events. There are maps available for these events to show the surface water flooding in the vicinity of the site. These are considered to be more accurate than the maps published by the EA on their website. LCC agreed to forward a copy to BHE. (Post meeting note: maps now received from LCC)
- BHE advised that surface water run-off would continue to be discharged into the docks, including the waterway proposed between the Stadium and Car Park that will connect Nelson Dock to Sandon Half-Tide Dock. New outfalls are proposed through

new walls wherever viable, one is required through the existing dock wall but is proposed to be incorporated into the new isolation structure at the northern end of the waterway, to be hidden from view.	
• LCC requested that the invert levels for the surface water outlet pipes are above the maximum water level of 5.16m AOD. BHE advised that this may not be possible due to the length of pipe required and the need to meet self-cleansing gradients/velocities, BHE will keep the drainage as high as possible. BHE to review.	BHE
• LCC advised that for a site recently brought forward for planning within the docks, Peel Ports had a requirement to have discharge velocities lower than 0.5m/s into the Docks. LCC recommended to discuss with Peel Ports if they are affected by the development.	
• LCC require no flooding of site for a 1 in 30 event and whilst for a 1 in 100 year event, ponding is acceptable, storage on site should be avoided for match days. LCC to forward on their guidance document for planning. (Post meeting note: info now received from LCC)	
• UU advised that they have studies of all surface water drainage to Sandon dock. UU suggested BHE to contact them if they require further information.	BHE
• BHE advised that rainwater harvesting was being considered for the development.	
• BHE explained that wave overtopping will need to be incorporated within the drainage network.	
6.2 Water Quality	
• BHE explained that a SuDS viability assessment had been completed and features at the top of the SuDS hierarchy (open ponds, swales and the like) were not considered appropriate given the context of the site. BHE are proposing to use mechanical means such as vortex separators to improve water quality prior to discharge into the docks. In low risk areas, over edge drainage was proposed to be maintained. LCC agreed with this approach.	
• LCC advised that Environmental Health and the EA would be consulted regarding water quality.	
7.0 Any Other Business	
7.1 The EA confirmed that the River Mersey is an Ordinary Watercourse and therefore Flood Risk Environmental Permits were not required.	
7.2 LCC recommended including a section on the Sequential Test within the FRA.	

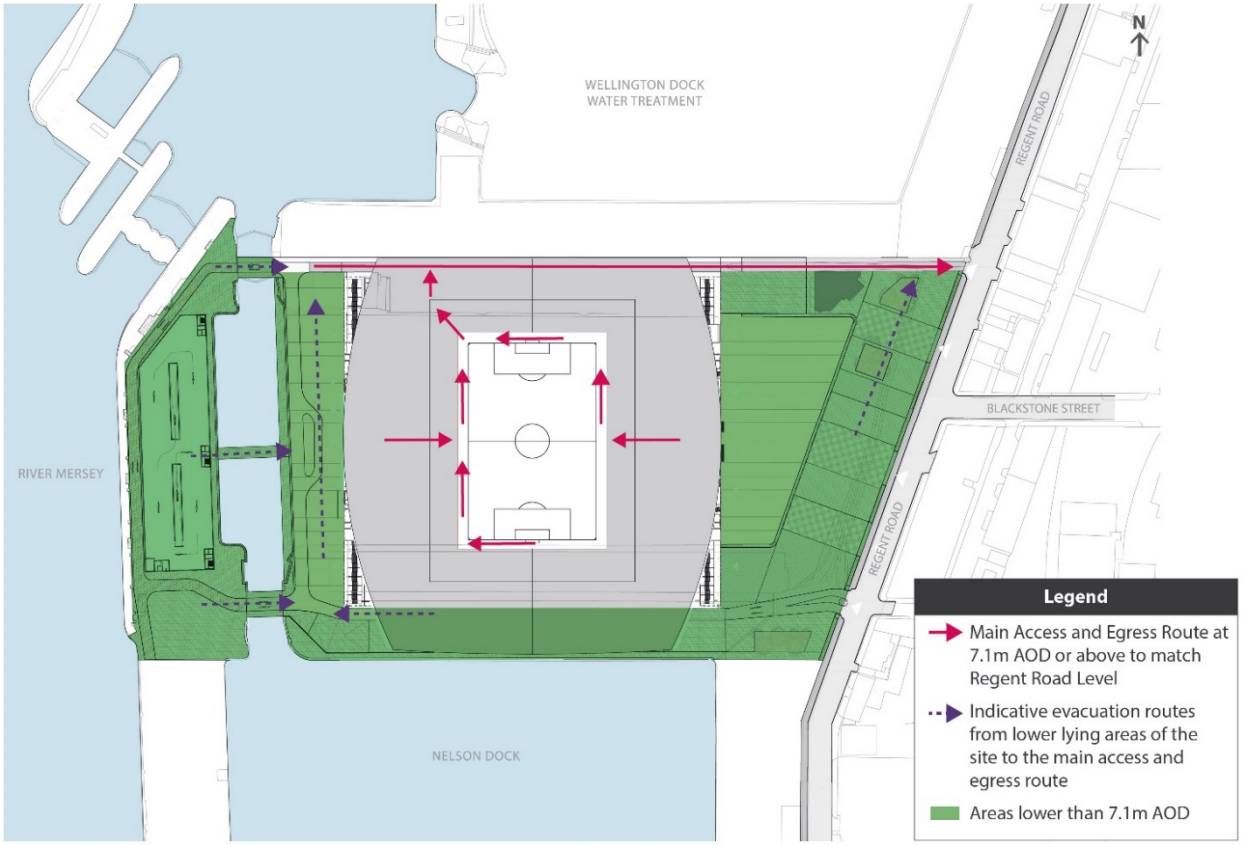
The minutes detailed herein reflect the author's recollection of the discussions held during the meeting detailed above. If you feel that these minutes are inaccurate; proposed additions, corrections and/or comments must be submitted to the author in writing within five working days of the date of these minutes. If no written responses are received within this period, these minutes will be deemed the official record of the meeting.

Minutes taken by: Clare Jones

Appendix A Minimum Development Levels



Appendix B Safe Access and Egress Route



BUROHAPPOLD ENGINEERING

Minutes

Subject	The People's Project EA Consultation - Flooding & WFD	Job no	0040026
Place	EA Office Warrington	Date	06 November 2019
Present	Graham Bate (EA) Bonnie Boulton (EA) Dominic Flynn (CBRE) Matthew Vaughan-Shaw (BuroHappold) Matthew Davison (Carcinus) Phil Preston (WYG)	Apologies	Stephen Sayce (EA)
Distribution	Above + Steve Macey (BuroHappold) Lloyd Baker (BuroHappold) Georgina Dowling (CBRE)		

Objectives of meeting:

1 – Agree in principle the response to new flood zone mapping within the FRA

2 – Agree in principle the approach to wave overtopping assessment within the FRA

3 – Agree the WFD Assessment Scoping and general approach to the assessment

Item	Action
1.0 Flood Zone Mapping	
1.1 Graham Bate (GB) noted that flood zone maps have been updated but the flood levels that inform the mapping remain unchanged. The changes in flood extents are therefore expected to be due to updates to the ground surface model.	
1.2 It was agreed that the project team hold more accurate topographic data than the ground surface model that the EA flood mapping is based upon. It is therefore appropriate for the project team to undertake its own assessment of flood zones using the topographic survey and the flood levels provided by the EA.	
1.3 Matthew Vaughan-Shaw (MVS) noted that updated flood level data was provided to BHE in January 2019 for use within the FRA. The document includes the note 'Model data taken from DRAFT Mersey Estuary 2016 Study'. The EA are requested to confirm that the levels remain valid for the	

purpose of the FRA. *(post-meeting note – the final flood report, Mersey Estuary, Ditton Brook and River Gowy, is dated December 2018; it is therefore expected that the levels supplied in January 2019 remain valid).*

2.0 Wave Overtopping Assessment

2.1 MVS noted that BuroHappold have submitted a request for access to the EA's wave modelling predictions. The model is summarised within the Mersey Flood Model Report, Appendix C, but does not contain model outputs at the development site.

2.2 GB confirmed that an enquiry has been submitted and he will follow up.

2.3 In the absence of model outputs BHE have developed an estimate of the wave conditions, for different return periods, at the development site. MVS described the methodology as follows:

- Wave data for variable return periods obtained for the nearest wave buoy within the Irish Sea
- Research multiple academic papers and modelling reports to estimate the relationship between the wave buoy location and the development site, i.e. identification of wave height reduction for different return periods from an offshore location to a location within the estuary
- Wave overtopping calculations using EuroTop methodology, and comparison with recommended safe limits for pedestrians and vehicles
- Identification of mitigation measures to protect pedestrians and vehicles during storm event and limit damage to structures. This will include closure of the river wall access road to pedestrians and vehicles. Access to the Outside Broadcasting Compound may be achieved via the southern access road, avoiding the need to drive alongside the river wall.

2.4 Dominic Flynn (DF) noted that the river wall is outside of the planning application boundary. Access along the crest of the wall is not part of the scheme and there will be a fence in place to prevent this.

2.5 The main uncertainty relates to the wave conditions. BHE will include a sensitivity assessment of the estimated wave conditions if the EA are unable to supply modelled wave data.

2.6 GB noted that the wave overtopping risks shall be considered as a residual risk within the FRA. The methodology and results should therefore be of sufficient reliability to inform the level of residual risk and mitigation measures needed. It was agreed in principle that the methodology described above would be sufficient for the FRA but would be improved if modelled wave data is available.

2.7 MVS noted that the FRA will outline the operational procedures that will need to be developed in relation to closure of the riverside road to pedestrians and vehicles. GB noted that Wirral Council now provide flood warnings linked to high winds and waves since wave overtopping contributed to flooding of New Brighton 2013. This information or similar may be available for the proposed development.

3.0 Water Framework Directive – Background Information

3.1 MVS provided background information relating to the proposed development and construction methodology. Key points of relevance to the WFD were noted:

- Bramley Moore Dock (BMD) is currently an operational dock, providing mooring for the port's tug boats.
- An isolation structure was constructed in 2005 to allow separation of the north and south dock water. The structure includes a series of culverts with sluice gates. MVS noted that there is anecdotal evidence that the sluice gates were closed for an extended period of time following construction which resulted in a noticeable change to the water quality conditions within the southern dock network. There is however no documented evidence of this.
- The dock will be infilled completely during the construction phase; towards completion of the construction phase a channel will be constructed to the west of the stadium to provide hydraulic connectivity between the north and south dock network;
- Material for dock infilling will be dredged from the Irish Sea from a licenced dredge site
- An new isolation structure will be installed within the northern entrance of BMD, this will include a series of culverts to match the existing isolation structure to the south; during construction phase the culverts will be blocked to prevent loss of sand during infilling
- The bed of BMD will be raked to remove objects that could result in voids occurring within the infill
- A geotextile membrane will be placed across the bed of BMD to separate the existing silt from the infill material to meet geotechnical requirements
- Infilling will be undertaken by the supply of a water-sand mix from a dredger moored in the River Mersey. The water-sand mix will be pumped via a floating pipeline and discharged into the dock basin. As the material is deposited, the water from the basin will be displaced. It is currently anticipated that this will be displaced to the north into the northern dock network.
- As noted above, the hydraulic connectivity between the north and south will be temporarily removed during the construction phase (approximately 2 years). It is proposed that monitoring (pre and during construction) will inform the requirement for pumping between the north and south dock networks to mitigate water quality risks.

3.2 MVS noted that the EIA and WFD assessment are not considering impacts of the dredging operations as they will be undertaken within a licenced site in the Irish Sea. The

4.0 Water Framework Directive – Scoping Overview

4.1 Bonnie Boulton (BB) noted that she had reviewed the draft scoping document issued by BHE together with inputs from specialists.

4.2 BB noted that the information in the scoping note can be simplified by only covering the consideration of potential impact. Information relating to

proposed mitigation should not be included within this stage of the process. 4.3 BB noted that information relating to timing of activities needs to be completed. 4.4 MVS noted that there are two potential water bodies that may require assessment: Mersey *Surface Water Body* and Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone Aquifers *Ground Water Body*. 4.5 MVS noted BHE's opinion that the development's ability to impact the Ground Water Body is negligible. Also noted that the main water quality issues associated with the Ground Water Body are defined as relating to agricultural pollution. Given the development site's location on the boundary of the Ground Water Body BHE propose that this may be scoped out. BB agreed with this approach and requested that this is documented and justified within the WFD Assessment Report. 4.6 MVS noted that the assessment will cover construction phase and operational phase. The construction phase will focus on the infilling and early works through to stadium sub structure. Stadium super-structure construction is likely to have limited impact and will not be covered in detail. During operational phase the focus of the assessment will be on surface water drainage impacts.	
5.0 Water Framework Directive – Hydro-morphology 5.1 BB agreed that this should be scoped in 5.2 BB advised that water quality issues should not be covered within this section 5.3 BB advised that the mitigation measures should include monitoring of the TSS within the displaced water during infilling operations.	
6.0 Water Framework Directive – Biology – Habitats 6.1 BB agreed that this should be scoped out based upon the scoping questions in the EA template. Reference may be made to the EIA chapter to highlight that wider assessment has been completed and mitigation measures proposed. 6.2 Benthic habitats within BMD have been characterised during 2017 site specific survey. This also included consideration of the fauna / flora growing on the dock walls.	
7.0 Water Framework Directive – Biology – Fish 7.1 BB agreed that this should be scoped in. 7.2 Matthew Davison (MD) noted the baseline survey methodology and key findings: - Site specific survey undertaken in 2017 to characterise fish assemblages within BMD; - Survey used a multi-method approach consisting of hydroacoustic (vertical and horizontal) analysis for biomass and density as well as static fyke netting. - Overall, fish densities within Bradley-Moore dock were reported to be relatively high at >3,000 fish per hectare observed throughout.	

Minutes taken by: Matthew Vaughan-Shaw

- Most common fish species recorded within the fyke nets was pouting *Trisopterus luscus* followed by coal fish *Pollachius virens*, European (silver) eel *Anguilla anguilla*, sole *Solea solea* and plaice *Pleuronectes platessa*.
- Report concluded that at the time of sampling, BMD was not considered a fish nursery and that the presence of European eel does not warrant special status.

7.3 MD noted that the key impact is considered to be associated with the dock infilling operation, with the requirement for fish capture in advance.

7.4 It was discussed and agreed that potential impacts upon fish movement due to the temporary and permanent condition of the western channel should be considered.

7.5 Aquatic ecology chapter baseline will draw from site specific survey and other available data to characterise likely fish populations within BMD and lower Mersey. This will include consideration of migratory species such as Atlantic salmon and European eel.

7.6 Guidance in relation to the construction and modification of culverts in respect to fish passage will be undertaken in view of the 'Culvert Design and Operation Guidance' (CIRIA, 2010) and Armstrong G.S et al., (2004). In addition to the Environment Agency Fish Pass Manual: Guidance notes on the Legislation, Selection and Approval of Fish Passes in England and Wales.

8.0 Water Framework Directive – Water Quality

8.1 BB agreed that this should be scoped in.

8.2 The potential to disturb contaminated sediment during the works was discussed. It was agreed that the risk is heavily reduced by the proposal

8.3 MVS noted that the disconnection of hydraulic connectivity between north and south dock network may result in water quality impacts. This will be covered within the WFD Assessment with the current proposed mitigation to undertake monitoring and pump if changes beyond trigger levels are observed.

8.4 Potential impacts from sediment bound contaminants will be considered within the ES. This will draw from the results of the 2017 site specific survey sediment chemistry analysis.

9.0 Water Framework Directive – WFD Protected Areas

9.1 MVS noted that the list of protected areas added to the scoping note may not all be within the 2km radius.

9.2 Philip Preston (PP) confirmed that a HRA is being undertaken for the project and that the conclusions will be presented within the WFD Assessment.

9.3 BB advised that the WFD Assessment should include reference to Natural England consultation.

9.4 BB advised that areas defined under the Nitrates Directive and Conservation of Wild Birds Directive should be checked.

10.0 Water Framework Directive – Invasive Species

10.1 MD confirmed that the list of invasive species provided in the scoping note were identified through survey of BMD in 2017.

10.2 BB queried whether Chinese Mitten Crab were identified. MD will check the survey report.

10.3 BB queried what are the proposed mitigation measures for dealing with invasive species?

10.4 MD noted that a Bio-Security Plan may be required to define mitigation measures. DF to check requirement for Bio-Security Plan as part of planning submission.

11.0 Water Framework Directive – Assessment Approach

11.1 MVS noted that the assessment will cover three broad areas:

- No deterioration assessment
- Protected areas assessment
- Future status assessment

11.2 MVS noted that the assessment will be predominantly qualitative, providing judgement of whether the impact will be negligible through to large.

11.3 Depending upon the findings of the qualitative assessment the project team will consider whether any further assessment is needed beyond the level of the ESIA to adequate cover the WFD assessment. Based upon the current understanding of the receptors, scales, activities and potential impacts the likelihood of any more detailed assessment is considered low. BB noted that this sounded reasonable based upon the information discussed.

11.4 MVS presented a spreadsheet tool that is proposed to be used for recording the assessment of potential impacts across the full range of WFD elements and proposed activities (construction and operational).

11.5 BB warned that the spreadsheet approach may lead to a lot of duplication of information where similar impacts apply. BB suggested that cells may be merged to create a simpler record of potential impacts. BB advised that the provision of a narrative against each section would be adequate in place of the spreadsheet. Agreed that project team would review best way of presenting the information within the assessment report.

Appendix B Wave overtopping

BUROHAPPOLD ENGINEERING

Design Note

Project The People's Project

Subject Wave Overtopping at the Bramley Moore Dock River Wall

Project no 0040026

Date 13 November 2019

Revision	Description	Issued by	Date	Approved (signature)
00	Draft	SM	15/10/19	
01	Updates to wave data and inclusion of uncertainty allowance	SM	13/11/19	MVS

1 Introduction

The purpose of this design note is to provide a summary of the wave overtopping analysis that was undertaken for the Bramley Moore Dock river wall in Liverpool to support the Flood Risk Assessment for Everton Football Club's new stadium. The location of the river wall in relation to development site and the wider River Mersey area is shown in Figure 1-1.

Located on the eastern bank at the mouth of the Mersey Estuary the development site is exposed to swell waves penetrating down the estuary from the Irish Sea, and to a lesser extent locally generated wind waves. Although the location of the development site in relation to the mouth of the estuary offers a good degree of protection from the large waves within the Irish Sea and the creation of oblique wave conditions, nonetheless large magnitude waves (>1.5 – 2.0m) are expected to be able to reach to site. This note will set out and discuss the effect of these waves on the development and the associated flood risk that they create through the assessment of:

1. Joint probability between extreme still water levels and different return period wave heights.
2. The methodology used to assess the discharge and volume of water overtopping the river wall
3. The results of that calculations, the impacts on the flood risk component of the development and any recommendations on how this can be mitigated and managed to maintain public safety.

Figure 1-1 - Bramley Moore Dock River Wall Location Plan

2 Joint Probability Analysis

The conditions leading to overtopping of the Bramley Moore Dock river wall are a result of a combination of incoming waves and still water created by the effects of tides and storm surges. A joint probability analysis utilising the simplified method for joint probability analysis contained within the *"Joint Probability: Dependence Mapping and Best Practice. Technical Report on Dependence Mapping, R&D Technical Report FD2308/TR1. March 2005"* that is published by Defra.

2.1 Extreme Still Water Level

Extreme still water levels for the wave overtopping assessment have been obtained from the Environment Agency's (EA) Coastal Flood Boundary Conditions for the UK: 2018 update database. The specific point used refers to Chainage 1168 (397107.3N 328.961.9E). Table 2-1 outlines the extreme still water levels for different return period events.

Table 2-1 - Extreme Water Level obtained from Environment Agency Coastal Flood Boundary Conditions database

Return Period (years)	Water Level (mOD)
1 in 0.01	*+4.58*
1 in 0.02	*+4.71*
1 in 0.05	*+4.88*
1 in 0.1	*+5.01*
1 in 0.2	*+5.13*
1 in 0.5	*+5.30*
1 in 1	+5.44
1 in 2	+5.56
1 in 5	+5.73
1 in 10	+5.86
1 in 20	+5.98
1 in 50	+6.16
1 in 100	+6.29
1 in 200	+6.42
NOTE: The water levels for return period events below 1 in 1 have been extrapolated from the general trend of return periods 1 in 1 to 1 in 200.	

Present day Mean High Water Springs (MHWS) and Highest Astronomical Tide (HAT) are reported to be +4.47mOD and +5.41mOD respectively.

It is noted that the 1 in 100 and 1 in 200 year water levels presented in Table 2-1 are 150mm and 160mm higher than the flood levels at BMD provided by the EA. The use of the Table 2-1 levels therefore represents a conservative approach.

2.2 Wave Conditions

An enquiry has been submitted to the EA to obtain site specific wave data for the development. However, to enable a level of risk to be establish BuroHappold have constructed a relationship between an the wave data recorded at the Gwent y Mor Directional Waverider Buoy within the Irish Sea and the development site via other information sources readily available to BuroHappold (e.g. internet searches, academic papers and correspondence on Flood Risk Assessments close to the development site). The outcome of this relationship are presented in Table 2-2.

Table 2-2 - Estimated Wave Parameters for the Development Site (without climate change and uncertainty allowance)

Return Period (years)	Significant Wave Height (m)	Wave Period (secs)
1 in 0.01	0.8	3.4
1 in 0.02	0.9	3.7
1 in 0.05	1.1	4.0
1 in 0.1	1.2	4.3
1 in 0.2	1.4	4.5
1 in 0.5	1.6	4.8
1 in 1	1.7	5.0
1 in 2	1.8	5.2
1 in 5	2.0	5.5
1 in 10	2.2	5.6
1 in 20	2.3	5.8
1 in 50	2.5	6.0
1 in 100	2.6	6.2
1 in 200	2.8	6.4

2.3 Climate Change

To take account of future sea level rise due to climate change the guidance within the National Planning Policy Framework (NPPF) for climate change allowances have been adopted for the North East areas of England. Taking 2019 as the base year and 2115 as the end year the sea level rise allowance was taken as a 915mm increase to present day levels.

To take account of the predicted increase in the magnitude of storms that affect the United Kingdom the NPPF also recommends an increase of 10% to the present day values of the significant wave height. This is added to the heights presented in Table 2-2.

2.4 Uncertainty Allowance

To take account of the uncertainties in the wave height estimations a 10% increase has been applied to the wave heights in Table 2-2. This is separate to the climate change allowance as in keeping with the NPPF guidance for sensitivity testing.

2.5 Joint Probability Test Scenarios

From inspection of Table 4.1 and Figure 4.1 of the Defra guidance document, the correlation coefficient between wave height and sea level is listed as $\rho = 0.2$, representing a modest correlation between the two variables. This equates to a correlation factor CF = 6.

Using this correlation factor, the water levels and wave heights listed in Table 2-1 and Table 2-2, the allowances for climate change and uncertainty, and the simplified method; Table 2-3 and Table 2-4 present the test scenarios for the present day and year 2115 cases respectively.

Table 2-3 - Joint Probability Water Level and Wave Height Test Scenarios (present day)

TEST	VARIABLE 1 Water Level		VARIABLE 2 Wave Height and Associated Wave Period															
			1 in 1 yr JP		1 in 2 yr JP		1 in 5 yr JP		1 in 10 yr JP		1 in 20 yr JP		1 in 50 yr JP		1 in 100 yr JP		1 in 200 yr JP	
	Return Period	Level (mOD)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)
1	1 in 0.01	4.58	1.84	4.87	1.96	5.04	2.13	5.26	-	-	-	-	-	-	-	-	-	-
2	1 in 0.02	4.71	1.68	4.66	1.85	4.89	2.03	5.13	2.20	5.36	2.35	5.55	2.56	5.85	2.64	5.95	2.85	6.24
3	1 ni 0.05	4.88	1.48	4.39	1.65	4.62	1.83	4.87	2.00	5.08	2.14	5.28	2.42	5.66	2.51	5.77	2.75	6.10
4	1 in 0.1	5.01	1.33	4.18	1.50	4.41	1.68	4.66	1.85	4.88	1.99	5.08	2.26	5.43	2.34	5.55	2.60	5.89
5	1 in 0.2	5.13	1.18	3.98	1.35	4.21	1.53	4.45	1.69	4.68	1.84	4.87	2.10	5.23	2.19	5.34	2.44	5.69
6	1 in 0.5	5.30	0.98	3.71	1.15	3.94	1.33	4.18	1.49	4.40	1.63	4.59	1.91	4.97	2.00	5.09	2.24	5.42
7	1 in 1	5.44	0.82	3.50	0.99	3.73	1.17	3.97	1.34	4.20	1.48	4.39	1.75	4.75	1.83	4.86	2.09	5.21
8	1 in 2	5.56			0.85	3.54	1.02	3.77	1.19	3.99	1.33	4.19	1.60	4.54	1.68	4.66	1.64	5.00
9	1 in 5	5.73					0.82	3.5	0.99	3.72	1.13	3.91	1.41	4.29	1.49	4.40	1.74	4.73
10	1 in 10	5.86							0.83	3.52	0.98	3.71	1.25	4.07	1.33	4.18	1.58	4.53
11	1 in 20	5.98									0.83	3.50	1.09	3.86	1.17	3.97	1.43	4.32
12	1 in 50	6.16											0.91	3.61	0.99	3.72	1.23	4.05
13	1 in 100	6.29													0.83	3.52	1.08	3.84
14	1 in 200	6.42															0.92	3.63

NOTE: Wave heights include a 10% increase (10% uncertainty allowance) over the values in Table 2-2

Table 2-4 - Joint Probability Water Level and Wave Height Test Scenarios (year 2115)

TEST	VARIABLE 1 Water Level		VARIABLE 2 Wave Height and Associated Wave Period															
			1 in 1 yr JP		1 in 2 yr JP		1 in 5 yr JP		1 in 10 yr JP		1 in 20 yr JP		1 in 50 yr JP		1 in 100 yr JP		1 in 200 yr JP	
	Return Period	Level (mOD)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)	Hs (m)	Tm (secs)
1	1 in 0.01	5.50	2.00	4.87	2.14	5.04	2.32	5.26	-	-	-	-	-	-	-	-	-	-
2	1 in 0.02	5.63	1.84	4.66	2.02	4.89	2.22	5.13	2.40	5.36	2.56	5.55	2.79	5.85	2.88	5.95	3.11	6.24
3	1 in 0.05	5.80	1.62	4.39	1.80	4.62	2.00	4.87	2.18	5.08	2.33	5.28	2.64	5.66	2.73	5.77	3.00	6.10
4	1 in 0.1	5.93	1.45	4.18	1.64	4.41	1.83	4.66	2.01	4.88	2.17	5.08	2.46	5.43	2.55	5.55	2.83	5.89
5	1 in 0.2	6.05	1.29	3.98	1.47	4.21	1.67	4.45	1.85	4.68	2.01	4.87	2.29	5.23	2.38	5.34	2.66	5.69
6	1 in 0.5	6.22	1.07	3.71	1.25	3.94	1.45	4.18	1.63	4.40	1.78	4.59	2.09	4.97	2.18	5.09	2.45	5.42
7	1 in 1	6.36	0.90	3.50	1.09	3.73	1.28	3.97	1.46	4.20	1.62	4.39	1.91	4.75	2.00	4.86	2.28	5.21
8	1 in 2	6.48			0.93	3.54	1.11	3.77	1.30	3.99	1.45	4.19	1.74	4.54	1.83	4.66	2.11	5.00
9	1 in 5	6.65					0.90	3.50	1.08	3.72	1.23	3.91	1.54	4.29	1.63	4.40	1.90	4.73
10	1 in 10	6.78							0.91	3.52	1.07	3.71	1.36	4.07	1.45	4.18	1.73	4.53
11	1 in 20	6.90									0.90	3.50	1.19	3.86	1.28	3.97	1.56	4.32
12	1 in 50	7.08											0.99	3.61	1.08	3.72	1035	4.05
13	1 in 100	7.21													0.91	3.52	1.18	3.84
14	1 in 200	7.34															1.01	3.63

NOTE: Water levels include a 915mm allowance for sea level rise and wave heights a 20% increase (10% climate change + 10% uncertainty allowance) over the values in Table 2-2

3 Assessment Cross Section

The Bramley Moore Dock river wall is characterised by a vertical blockwork wall extending from the river bed at a typical level of -4.44mOD to a typical wall crest level of +8.1mOD giving a wall height of approximately 12.5m. The crest itself is generally 4.5m wide before dropping down to a level of +6.6mOD. A typical section through the river wall is shown in Figure 3-1.

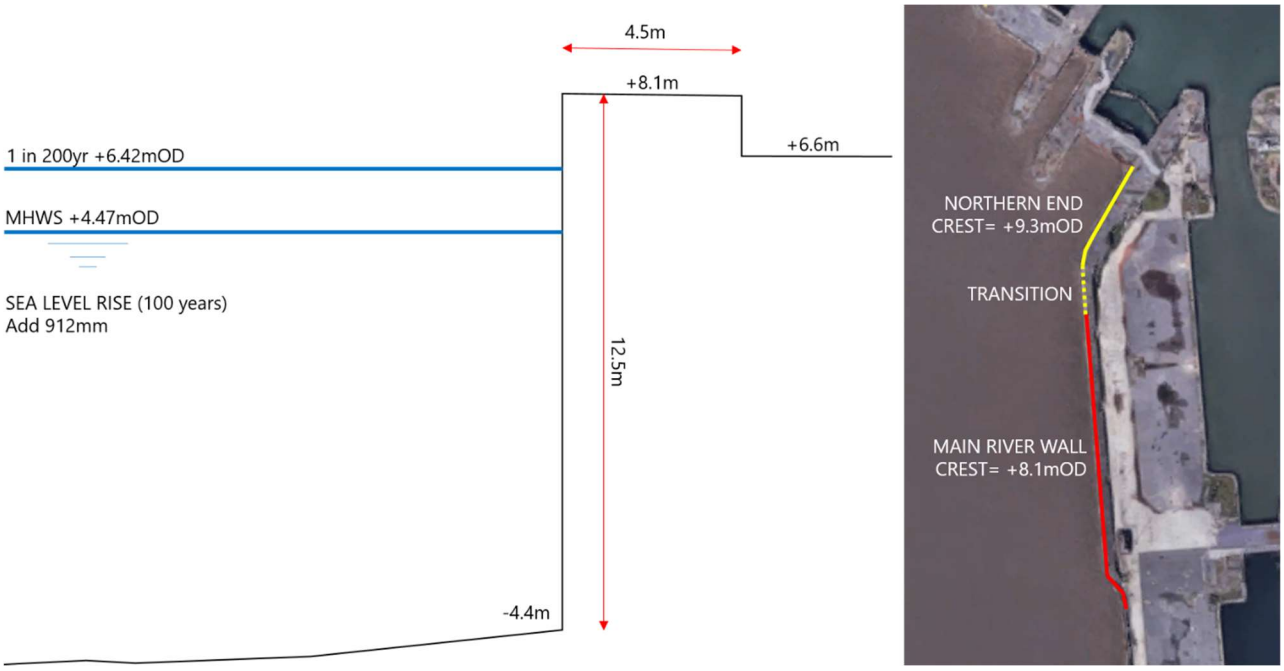


Figure 3-1 - River Wall Typical Cross Section and Crest Level location Plan

Towards the northern end of the river wall the crest level increases to a height of +9.3mOD with the crest width increasing to between 4.5m and 12.5m but is more typically 10m wide.

The majority of the river wall is orientated along a bearing of 175°N - 355°N. Given the orientation of the Mersey Estuary this creates a condition where the waves break on the wall at an oblique angle. This angle is assessed to be 60° normal to the river wall, reducing to 20° for the northern end of the river wall.

4 Overtopping Methodology

Assessment of the river wall was undertaken using the methods and assessments tools set out within EurOtop II "Manual on wave overtopping of sea defences and related structures, second Edition 2018". Within this guidance document the river wall at the development site is classed as a Vertical or Steep Wall and so the calculation procedures outlined in Section 7 shall be utilised for the assessment.

The flood risk component to the development site is twofold. The first is the risk of water travelling some distance behind the river wall, flooding the space behind and the second the risk to users of the space behind the wall such as pedestrian and vehicles. Using the guidance within Section 3 of the EurOtop II manual the safety limits set out within Table 4-1 shall be used to determine the level of risk to the development and its users.

Table 4-1 - Overtopping Limits for Pedestrian and Vehicles

Wave Height (m)	**Pedestrian Limits**		**Vehicle Limits**	
	Mean Discharge, q (l/s/m)	Maximum Volume, V_{max} (l/m)	Mean Discharge, q (l/s/m)	Maximum Volume, V_{max} (l/m)
≤1	10	600	75	2000
2	1	600	10	2000
≥3	0.3	600	5	2000
NOTE: For intermediate values between a 1m and 3m wave height interpolation shall be used				

5 Overtopping Results

The results of the wave overtopping analysis have been presented in four tables for the main river wall and the northern end of the river wall within Sections 5.1 and 5.2. Within each section are the results for the present day and the climate change scenario for the year 2115 where the maximum mean discharge, maximum individual wave volume, total discharge rate from that length of wall and the maximum safe storm event for pedestrian and vehicles.

In all cases the climate change scenario represents the greatest flood risk with the risk to pedestrians being greater than vehicles for any given storm.

The analysis has identified that the maximum discharges and volumes typically arise from the joint probability combinations with the largest waves. For these combinations the water levels are at the lower end of those presented in Table 2-2.

5.1 Main Section of River Wall

PRESENT DAY

Event Return Period	Mean Discharge, q (l/s/m)	Wave Volume, V (l/m)	Critical Wave Height, Hs (m)	Critical Still Water Level (mOD)	Pedestrian Limit				Vehicle Limit			
					q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?	q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?
1	0.025	247.0	1.84	4.58	2.44	YES	600	YES	20.4	YES	2000	YES
2	0.055	362.8	1.96	4.58	1.36	YES	600	YES	12.6	YES	2000	YES
5	0.145	546.3	2.13	4.58	0.91	YES	600	YES	9.35	YES	2000	YES
10	0.295	707.0	2.20	4.71	0.86	YES	600	NO	9.00	YES	2000	YES
20	0.566	932.1	2.35	4.71	0.76	YES	600	NO	8.25	YES	2000	YES
50	1.229	1326.8	2.56	4.71	0.61	NO	600	NO	7.20	YES	2000	YES
100	1.595	1500.8	2.64	4.71	0.55	NO	600	NO	6.80	YES	2000	YES
200	3.141	2039.6	2.85	4.71	0.41	NO	600	NO	5.75	YES	2000	NO

Maximum Mean Discharge Rate, q = 3.14l/s/m

Maximum Individual Wave Volume, V = 2039.6l/m

Total Discharge Rate, Q = 3.14l/s/m * 167m = 524.4l/s = 0.53m^3/s

Maximum Safe Storm Event for Pedestrians = 1 in 5 year

Maximum Safe Storm Event for Vehicles = 1 in 100 year

CLIMATE CHANGE CONDITION (YEAR 2115)

Event Return Period	Mean Discharge, q (l/s/m)	Wave Volume, V (l/m)	Critical Wave Height, Hs (m)	Critical Still Water Level (mOD)	Pedestrian Limit				Vehicle Limit			
					q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?	q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?
1	1.104	939.8	2.00	5.50	1.00	NO	600	NO	10.0	YES	2000	YES
2	1.912	1223.5	2.14	5.50	0.91	NO	600	NO	9.30	YES	2000	YES
5	3.496	1669.9	2.32	5.50	0.78	NO	600	NO	8.40	YES	2000	YES
10	5.931	2141.3	2.40	5.63	0.72	NO	600	NO	8.00	YES	2000	NO
20	8.889	2720.0	2.56	5.63	0.61	NO	600	NO	7.20	NO	2000	NO
50	14.857	3734.2	2.79	5.63	0.45	NO	600	NO	6.05	NO	2000	NO
100	17.763	4179.6	2.88	5.63	0.39	NO	600	NO	5.60	NO	2000	NO
200	28.427	5569.5	3.00	5.80	0.30	NO	600	NO	5.00	NO	2000	NO

Maximum Mean Discharge Rate, q = 28.43l/s/m

Maximum Individual Wave Volume, V = 5569.5l/m

Total Discharge Rate, Q = 28.43l/s/m * 167m = 4747.8l/s = 4.75m^3/s

Maximum Safe Storm Event for Pedestrians = **UNSAFE FOR ALL EVENTS**

Maximum Safe Storm Event for Vehicles = 1 in 5 year

5.2 Northern End of River Wall

PRESENT DAY

Event Return Period	Mean Discharge, q (l/s/m)	Wave Volume, V (l/m)	Critical Wave Height, Hs (m)	Critical Still Water Level (mOD)	Pedestrian Limit				Vehicle Limit			
					q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?	q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?
1	0.007	Negligible	1.84	4.58	2.44	YES	600	YES	20.4	YES	2000	YES
2	0.017	178.3	1.96	4.58	1.36	YES	600	YES	12.6	YES	2000	YES
5	0.051	661.2	2.13	4.58	0.19	YES	600	NO	9.35	YES	2000	YES
10	0.102	938.0	2.20	4.71	0.86	YES	600	NO	9.00	YES	2000	YES
20	0.213	1261.1	2.35	4.71	0.76	YES	600	NO	8.25	YES	2000	YES
50	0.513	1734.8	2.56	4.71	0.61	YES	600	NO	7.20	YES	2000	YES
100	0.689	1926.8	2.64	4.71	0.55	NO	600	NO	6.80	YES	2000	YES
200	1.372	2491.8	2.85	4.71	0.41	NO	600	NO	5.75	YES	2000	NO

Maximum Mean Discharge Rate, q = 1.37l/s/m

Maximum Individual Wave Volume, V = 2491.8l/m

Total Discharge Rate, Q = 1.37l/s/m * 54m = 73.98l/s = 0.08m^3/s

Maximum Safe Storm Event for Pedestrians = 1 in 2 year

Maximum Safe Storm Event for Vehicles = 1 in 100 year

CLIMATE CHANGE CONDITION (YEAR 2115)

Event Return Period	Mean Discharge, q (l/s/m)	Wave Volume, V (l/m)	Critical Wave Height, Hs (m)	Critical Still Water Level (mOD)	Pedestrian Limit				Vehicle Limit			
					q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?	q_{max}	$<q_{max}$?	V_{max}	$<V_{max}$?
1	0.237	Negligible	2.00	5.50	1.00	YES	600	YES	10.0	YES	2000	YES
2	0.466	1328.8	2.14	5.50	0.91	YES	600	NO	9.30	YES	2000	YES
5	0.981	1727.8	2.32	5.50	0.78	NO	600	NO	8.40	YES	2000	YES
10	1.693	2049.1	2.40	5.63	0.72	NO	600	NO	8.00	YES	2000	NO
20	2.807	2515.8	2.56	5.63	0.61	NO	600	NO	7.20	YES	2000	NO
50	5.213	3324.7	2.79	5.63	0.45	NO	600	NO	6.05	YES	2000	NO
100	6.456	3677.6	2.88	5.63	0.39	NO	600	NO	5.60	NO	2000	NO
200	10.745	4718.2	3.00	5.80	0.30	NO	600	NO	5.00	NO	2000	NO

Maximum Mean Discharge Rate, q = 10.75l/s/m

Maximum Individual Wave Volume, V = 4718.2l/m

Total Discharge Rate, Q = 10.75l/s/m * 54m = 580.5l/s = 0.58m^3/s

Maximum Safe Storm Event for Pedestrians = 1 in 1 year

Maximum Safe Storm Event for Vehicles = 1 in 5 year

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